Recurring Aerial Imagery Acquisition Program

MSB Project No. 16-130

Report 1 of 5

Successful Recurring Imagery Programs

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Acronyms

AGC .....Alaska Geospatial Council
AGO……Arkansas GIS Office
ASDI .....Arkansas Spatial Data Infrastructure
ASPRS .....American Society of Photogrammetry and Remote Sensing
CIAP .....Coastal Impact Assistance Program
DEM.....Digital Elevation Model
DOQQ.....Digital Orthophoto Quadrangle
DTM.....Digital Terrain Model
FAQ.....Frequently Asked Questions
FEMA .....Federal Emergency Management Agency
GIS .....Geographic Information System
GSD.....Ground Sample Distance
KFA.....Kentucky From Above
LiDAR.....Light Imaging, Detection, and Ranging
MEGIS .....Maine Office of GIS
MEDOT .....Maine Department of Transportation
MOU .....Memorandum of Understanding
MSB .....Matanuska Susitna Borough
NAIP .....National Agriculture Imagery Program
NASA.....National Aeronautics and Space Administration
NRCS .....Natural Resource Conservation Service
PSLC .....The Puget Sound LiDAR Consortium
QA.....Quality Assurance
QBS.....Qualifications Based Selection
QC .....Quality Control
RFQ.....Request for Qualifications
RFP .....Request for Proposal
RGB .....Red, Green, Blue
RPC.....Regional Planning Commission
SCO.....Wisconsin State Cartographer’s Office
UCL.....Remote Sensing
USGS .....United States Geological Survey
URISA.....Urban and Regional Information Systems Association
WIP .....Wisconsin Land Information Program
WMS.....Web Mapping Services
WROC.....Wisconsin Regional Orthoimagery Consortium

Executive Summary

Aerial imagery is used by local governments throughout the United States to meet daily business needs. Imagery has many uses, including providing a common operating picture and accurately mapping the locations of natural and man-made features.

Access to current imagery improves business efficiency and informs decision making. Having regularly updated imagery in the Matanuska Susitna Borough (Borough) is becoming increasingly needed and expected by Borough employees, business partners, and the public.

The Borough wishes to establish a recurring imagery program that includes a repeatable process, a clear understanding of customers' needs, identification of consistent funding and cost savings measures, an understanding of available technologies, and a clear implementation plan.

This report summarizes an investigation of seven successful recurring aerial imagery programs nationwide. The report identifies factors contributing to these programs success and outlines key lessons for building a successful program at the MSB. The key findings and recommendations of this investigation are provided below:

Key Findings

Partnerships and Consortiums

The success of the programs we evaluated is largely based on partnerships that share the costs of imagery acquisition. Many of these programs have evolved into partnerships or consortiums consisting of a variety of partners, some cases as many as 40 partners. The partnerships we reviewed vary in their approach, but typically consist of:

- Local governments (counties, cities),
- State government,
- Federal government,
- Other: land management groups, non-profit organizations, and
- In some of these programs a vendor/contractor also played a critical role in ensuring the acquisition was properly managed and technical resources were available.

The programs were initiated and formed for the following reasons:

- To provide imagery at less cost to members,
- Provide coordinated imagery acquisition in their area,
- Ensure imagery could be distributed to those who need it, and
- Provide the resources needed to manage acquisition, ensure imagery quality met user needs, and make the acquisition more cost efficient.

In terms of organizational structure, the programs we studied have the following common elements:

- A centrally managed imagery program housed usually in the GIS or IT departments. In most cases the imagery acquisition and technical aspects were largely provided by a contracted vendor,

- A well-defined quality based selection and procurement process,
- Specifications based on a careful user needs analysis,
- Provision for adequate staffing resources, both in terms of project management and technical support, and
- A partner agreement (MOU, contractual agreement) that ensures the partners are committed to the program.

Program Funding and Costs

We found that generating more revenue for an acquisition program and cost savings can be achieved in a number of key ways:

- Using a collective approach where partners share imagery acquisition costs in an equitable manner. Some programs rely on a large number of participants, while others depend on a small, core group of funding partners (e.g. Spokane County).
- Developing sustainable mechanisms for generating revenue for imagery acquisition. For example, Wisconsin's program funding is derived from a long-term fee that is part of property transactions; and Spokane County charges fees for imagery use in addition to partner funding.
- A repeatable process that includes a well-defined imagery specification and procurement process saves time and effort, and
- A system for imagery and related (e.g. LiDAR) data delivery helps increase partner membership and contribution, and ensures program longevity.
- Allocating a set percentage of funding to an acquisition budget for management and technical support saves on internal staffing costs. For example, Puget Sound LiDAR Consortium allocates a 14 percent overhead fee to their acquisition projects to help pay for management and technical support.

Staffing Resources

Staffing resources are critical to the successful operation of any imagery acquisition program. The following trends were discovered:

- Most of the programs are managed and administered by an agency program manager who has played a strong role in building the program. These managers develop and oversee the selection process, develop the RFQ/RFP and partnership MOUs, and the determine the technical specifications.
- Acquisition project management is most often provided by the acquisition vendor, or sometimes in partnership with the program manager.
- Technical review and QA/QC of the imagery tends to be mostly done by the vendor and in some cases a third-party peer review group or secondary vendor.
- Some programs have successful vendor managed programs. These vendors have a trusted relationship with the overseeing agency, adequate technical resources to complete the project to requirements, and are heavily invested in the region.

Regardless of where the resources come from, all of the program managers we talked to stress the importance of funding for project management and for technical QA/QC staffing.

Stakeholders and Partners

Key stakeholders in the programs most often consist of local communities (counties, cities), and non-profits. State and/or federal agencies do not tend play a strong role in the programs we studied, with the exception of Arkansas and Kentucky who rely mostly on federal and state government funding respectively.

Determination of Business Needs

Key programs such as Kentucky, Maine, and Wisconsin have developed business needs plans and specific Use Cases that have helped them secure funding, as well as define their specifications. For examples, see Appendix A. These help educate existing and prospective partners. In all of the programs studied, a key part of the overall business case is the need for a mutually funded imagery that supports a variety of stakeholder needs.

Imagery Acquisition areas, Prioritization, Type, and Refresh Cycle

The geographic size of acquisition areas varies widely amongst the programs. All of the programs studied emphasize the efficiency of acquiring imagery in as large an area (regionally) as possible for economy of scale.

In the programs we evaluated, acquisition areas typically fall into these categories (shown with resolution and imagery type):

- Rural (countryside, hinterlands): 1 foot pixel (GSD), RGB
- Urban (e.g. city): 3 to 6 inch pixel RGB
- Regional (city and rural, and typically in the order of 3,000 plus square miles): 1 – 2 foot pixel RGB

Imagery quality and acquisition is improving with time, and many of the programs are opting for digital orthoimagery at higher resolutions for the types of areas listed. Drones (also known as Unmanned Aerial Systems) are not used in any of the programs we studied, due to the fact that the programs we evaluated usually focus on county or city-wide and more regional scope acquisitions. A type of imagery called "Pictometry™" is utilized in some cases for urban area imagery to meet the needs of assessors. Satellite imagery is not used by any of the programs we evaluated, with the exception of a Wisconsin group called "Wisconsin View" which is a more academically research oriented program.

The typical cycle period of imagery acquisition ("refresh") is two to three years for urban imagery, and three to five years for rural areas.

LiDAR

LiDAR acquisition varies amongst the programs, but it is increasingly being acquired to supplement imagery. Most of the programs evaluated are either acquiring LiDAR or planning to do so.

Licensing, Fees, and Distribution Methods

Most of the programs make imagery data accessible in the public domain. Wisconsin has varying policies statewide, and some counties sell the data. Data distribution is trending towards online distribution of data, where the user can download data by tile. Kentucky emphasizes that a timely imagery delivery service improves customer satisfaction, and ultimately helps get more partner funding. Online imagery services are now a key part of the programs at Spokane County and Kentucky, and the other programs are moving this direction.

Keys to Success

- Strong partnership based programs, the main examples being the Puget Sound LiDAR Consortium, Wisconsin, and Maine.
- Provision of adequate project management, program management, and technical resources to ensure the program functions well.
- A program process that can be repeatedly used and is characterized by these core components:
    - a standard RFQ or RFP,
    - a Contract or MOU that binds the partnership together, and
    - a set of thorough specifications. Examples are: Spokane County, Wisconsin, Maine, Kentucky. See Appendices 1 and 2 for references to supporting documentation.

Recommendations

1. **Utilization of a partnership approach** for funding of the recurring aerial imagery program. As mentioned above there are a number of strategies that have been successful. It is important to note that development of a partnership or consortium organization takes time. Most of the programs evaluated did not evolve these programs "overnight." A key example is Wisconsin where development of the consortium evolved over a period of five years with a long history of county acquisitions before that.

2. **Development and utilization of a clearly defined programmatic process** consisting of the following components. All of the following items are important, but in particular the specification and procurement (RFP) are the first steps in program development.
    a. Base product **specification**: this addresses ASPRS Class II best practices, but also local needs such as leaf-off seasonality, urban vs. rural resolutions, etc.
    b. A clear and carefully developed vendor selection process that uses an RFQ/RFP based on successful similar documents used in other programs.
    c. Contract Agreement between the program manager and partner that is usable over the long term (for example 5 years), and

3. **Development of sustainable funding mechanisms**. Program funding can be achieved using a variety of options as shown by the programs evaluated in this study. Reliance on a very small number of sources can be risky, although Spokane County shows that this can work over a long term and with a well-developed program. Spokane County also utilizes a per computer charge for imagery services. It is recommended that the Borough consider an approach that incorporates a number of funding methods. This will be

addressed in the Funding Opportunities Report. Program funding should include sufficient funding for administration and staffing resources to support an imagery acquisition project.

4. **Development of a strong business case** to justify the program and to define user needs and specifications. The Use Cases and correlative imagery specifications will also be useful as educational and marketing tools for increasing funding participation. The programs described in this report offer good examples of business case development.

5. **A stable and well "oiled" data delivery system (e.g. data clearinghouse)** will likely have a high return on investment as shown by the examples of Kentucky, Spokane County, and Wisconsin.

6. **Learn from others experience**. Aerial data acquisitions on a regional scope have been undertaken recently or are slated for 2017 by King County, Maine, and Puget Sound LiDAR. These programs in particular may be able to offer additional information to the Borough if it develops a recurring aerial imagery acquisition program.

1 Introduction

This report describes a number of successful aerial imagery programs nationwide, and identifies the factors contributing to their success. Other reports developed for the Matanuska Susitna Borough (MSB) Recurring Aerial Imagery Program will analyze the technical specifications of imagery options, business needs, and funding opportunities.

The MSB is located in southcentral Alaska and at 25,258 square miles is one of the largest local governments in terms of area in the United States. By comparison, the largest county in Maine (one of the programs studied in this report) is about 7,000 square miles and King County, Washington is 2,300 square miles in area. The MSB is experiencing the most rapid development of any community in Alaska, having grown from a population of 5,200 to 102,000 in the past 55 years.

This report summarizes the reviews of seven successful programs located in Washington, Wisconsin, Kentucky, Maine, and Arkansas and assesses the factors that have made them successful, as well as identifying the challenges each program has faced. Each of the programs was analyzed in terms of:

- Program Overview
- Program Funding and Costs
- Staffing
- Stakeholders, Partners, Consortiums
- Determination of Business Needs
- Frequency of Imagery Acquisition and Procurement Methods
- Imagery Types and Specifications
- Typical Size of Acquisition Areas; Prioritization Method
- Imagery Specifications
- LiDAR Acquisition
- Data Licensing, Fees, Distribution
- Keys to Success, and
- Lessons Learned

The information above is summarized for each program in Tables 1 to 7. A summary matrix comparing all of the programs is provided in Appendix F.

This report is based on an extensive review of the other program's documentation and websites, and personal interviews with program managers. The Urban and Regional Information Systems Association (URISA) and American Society of Photogrammetry and Remote Sensing (ASPRS), and Alaska Geospatial Council were helpful in providing initial contact information regarding successful imagery programs in the U.S. We thank the following individuals who generously provided their time and information, including: Ian Von Essen (Spokane County); Andy Norton (Puget Sound LiDAR Consortium); Kent Anness (Kentucky From Above); Joe Young (Maine Orthophoto Program); Andy Faust (WROC); Jim Lacy (Wisconsin State Cartographer's Office); Shelby Johnson (AGO); Allen Grissom (City of Seattle), and David Doyle (Seattle Open Data). Thanks also to Brian Wright, Alaska USGS, and Anne Johnson, Alaska Geospatial Council for information regarding Alaska programs.

2 Research Methods and Approach

A pool of candidate imagery programs was developed based on references from URISA, ASPRS, the United States Geological Survey (USGS), and the Matanuska Susitna Borough. From this pool, seven programs were selected for this study based on these criteria:

- Successful imagery acquisition and application.
- Successful funding and management approaches.
- Similarity to Alaska in terms of area sizes, population, and mixes of urban and rural density.
- A cross-section of the U.S., for example from the Northwest, Midwest, East Coast, and Southeast.
- Successful partnership or consortium programs.
- Longevity of the program, or progressive development of a recurring acquisition program. It is important to note that some of the recurring programs studied in this report have actually only been established fairly recently (for example five years ago), but they have settled on a recurring program after many years of unplanned and less cost-effective programs. King County, for example, has been acquiring aerial photography since 1936, but has established a regional imagery consortium only since 2012.

The programs studied in this report include the following:

- Kentucky: Kentucky from Above program
- Washington:
    - Puget Sound LiDAR Consortium,
    - King County Orthoimagery Program
    - County of Spokane
- Maine: Maine Orthophotography Program
- Wisconsin: Wisconsin Orthoimagery Consortium
- Arkansas: Arkansas GIS Office Orthophotography Program

Alaska local governments were also considered, but we did not include them in this analysis because recurring programs in Alaska are very limited or not fully developed at this time.

Data was gathered from the programs' websites and reference documents and from telephone conversations with personnel which provided more detailed information. A matrix of topics was used when gathering data to give the process structure and it provided a way to compare the different programs. Costs provided may be dated and should not be used for estimating.

Assumptions

- Local government needs for aerial imagery are very similar from region to region.
- Technology options considered are equally available in the programs studied.
- GIS is the fundamental platform using the imagery.

3 Results of Research

The seven programs investigated are profiled below.

3.1 Kentucky From Above

Program Overview

Kentucky's Statewide Digital Aerial Photography and Elevation Basemap Program known as Kentucky From Above (KFA) provides a common digital mapping base for the state and local government and the private sector. The KFA program began with the need to eliminate redundant spending on imagery acquisition. There were multiple entities wanting data for the same areas therefore it only made sense to pool resources. Prior to KFA, there was one instance where a single county was flown twice in one year. The current program has been in place since 2010 and is well established with specifications. It includes a clear stakeholder group that is invested in the program and has established the infrastructure and technical resources to distribute orthoimagery and LiDAR data online to its partners. A common imagery base data set, including current, color, and leaf-off aerial photography and elevation data (LiDAR), reduces the cost of developing GIS applications, promotes data sharing, and adds efficiencies to many state agency business processes. KFA is also highly visible in the GIS and mapping community in Kentucky with a wide range of applications. Figure 1 below shows an example "Story Map" developed as part of the KFA program to help educate the public and its partners about the program. Appendix A includes a summary of the KFA Use Cases as developed through their Business Needs Analysis.

Figure 1. Kentucky From Above Website

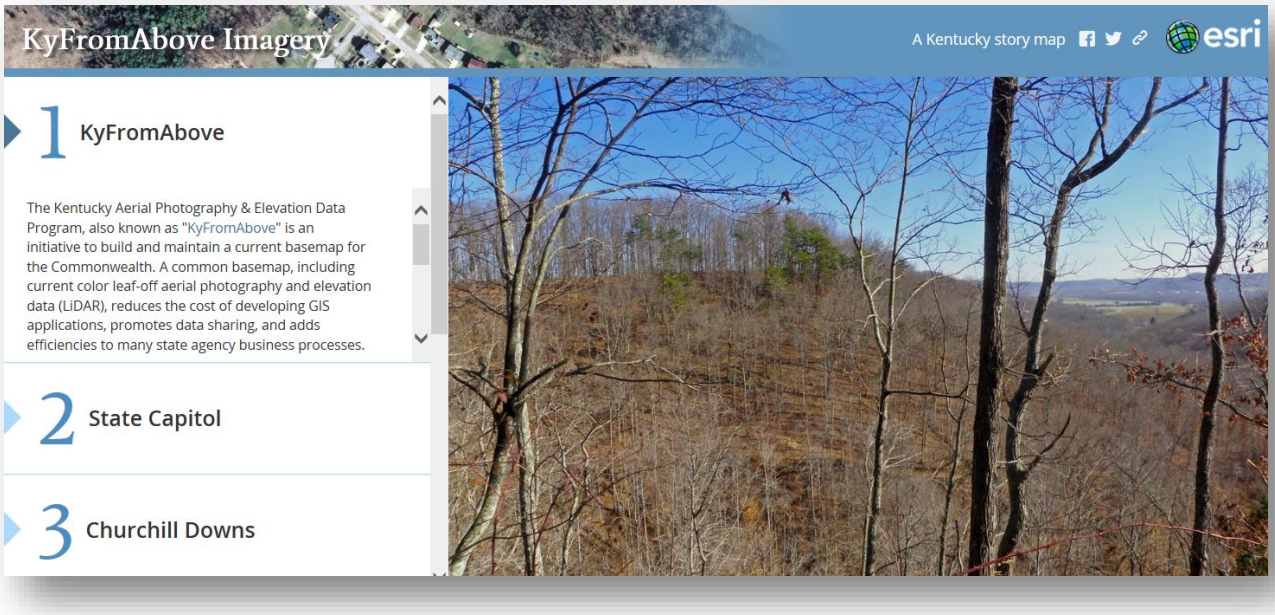

Table 1. Kentucky Program Summary Profile

Program Funding and Costs	
Funding sources	The KFA program has received funding from all levels of government (local, regional, state, federal) as well as universities. The largest contributors have been the Kentucky Transportation Cabinet, NRCS, and FEMA.
Annual costs and per square mile cost	The orthoimagery program initiating in 2017 will be a multi-million-dollar project and is expected to span a 3 to 4-year period.
Staffing	
Administrative	KFA's orthophotography program team has three staff members: one manager/administrator, a GIS technician, and an IT-focused support person who manages data distribution.
Technical	Quality assurance/quality control (QA/QC) staff: the "draft" imagery is reviewed online by partners where they can review it for completeness, quality, and other needs. Training is provided for partners on what to look for, e.g. look for smear, bad elevation.
Stakeholders, Partners, Consortium	
Stakeholders and/or Partners	There is a total of 20 partners/stakeholders in the KFA program. The program uses an MOU to bind the partners to commitments in funding. State and other local government partners include: Kentucky Transportation Cabinet, Kentucky Abandoned Mine Lands, Kentucky Division of Geographic Information, Kentucky Division of Water, Kentucky Geological Survey, Louisville-Jefferson County Information Consortium, Frankfort Plant Board, Boone County Planning Commission, City of Florence, Hardin County Fiscal Court, Hopkins County Fiscal Court, and Paducah/McCracken County, Tennessee Valley Authority, Kentucky State University, and Link-GIS/NKAPC. Federal stakeholders include: Natural Resources Conservation Service, United States Geological Survey, Federal Emergency Management Agency, and Department of Defense - Fort Knox.
Consortium	A formal consortium organization is not established. KFA is a consortium in the sense that it has an established participating group using a common agreement to bind the partners to funding over a long term.

Determination of Business Needs	
Use Cases	Use Cases have been developed (see Appendix A). The KFA program has stressed the development of Use Cases and a strong business justification. This effort started with the development of a technical committee representing the 20 partners. Many times the Use Cases were the catalyst and once the data started to be used, other uses emerged.
Frequency of Imagery Acquisition and Procurement Methods	
Frequency of acquisition	Regional acquisitions occur every five years.
Procurement Method	A contract for aerial photography and elevation data acquisition was awarded to a vendor as part of long term contract.
Typical Size of Acquisition Area; Prioritization Method	
Acquisition Area Size	Twenty-seven percent of the state or 16,000 square miles was covered with aerial imagery in the last acquisition.
Prioritization method	No prioritization method is employed.
Imagery Specifications	
Resolution	Rural areas: 6-inch and 1-foot. Urbanized areas: 3-inch pixel
Type of imagery	RGB orthoimagery.
LiDAR	
Part of the Program?	Yes. The USGS has contributed $1 million towards LiDAR acquisition.
Data Licensing, Fees, Distribution	
Licensing & Fees	Access to the imagery data is available in the public domain.
Distribution	The imagery and LiDAR data is available online for download.

Keys to Success	
	Developed Use Cases that included a description of how the imagery data could demonstrate cost savings. Part of the business needs analysis consisted of visiting with each of the partners to find out how they will use the data, but now the users are finding more ways to use the data. Developed a clear set of specifications that exceed federal specifications. Strong effort into the development of an effective data distribution system that is online and easy to use, and is easier for staff to distribute. KFA's collective approach has increased the return on investment significantly for all involved.
Lessons Learned	
	Defining the needs of users carefully, for example engineers and emergency response personnel are crucial to funding aerial imagery. In the case of engineers and public safety, they see the value of having high quality and high resolution data and are increasing their applications of this data. The Planning/Appraisal department can use imagery options that support higher resolution and are suitable for building measurements. Determine most appropriate imagery for the Use Case. Defining Use Cases and using them to sell the program is important to achieve support of the stakeholders.

3.2 King County

Program Overview

King County is one of the older GIS programs in the U.S., and the county has had aerial imagery acquisition programs since 1936. In 2008 a collaborative group of cities and King County staff established a partnership program. This was driven by the need to reduce costs, provide imagery to local cities in the region, and acquire imagery on a more regional scale.

The City of Seattle and King County initiated a large partnership of more than 100 stakeholders to acquire imagery for the entire county in 2010. This effort began with the development of a selection process including an RFP. In 2012, King County developed the first regional project where they contracted with the various jurisdictions and involved them in the process of selecting the vendor and sponsoring the project.

The 2012 effort started slowly due to a lack of internal project management resource; but continued in part because the County and other partners stepped up to provide program management. The vendor selected provided the bulk of project management resource, and by 2015, a team approach amongst the county, City of Seattle and others, and the vendors resulted in a successful regional acquisition of imagery.

The King County partnership includes large and small cities, most notably the City of Seattle, which has a very strong, well-established GIS program. As a result of the partnership program, the cities received the imagery data for half price (plus a 15% administrative fee charged by the county). Another advantage is that the region received a uniform data set flown by a single vendor.

Figure 2. King County Orthophotography Website

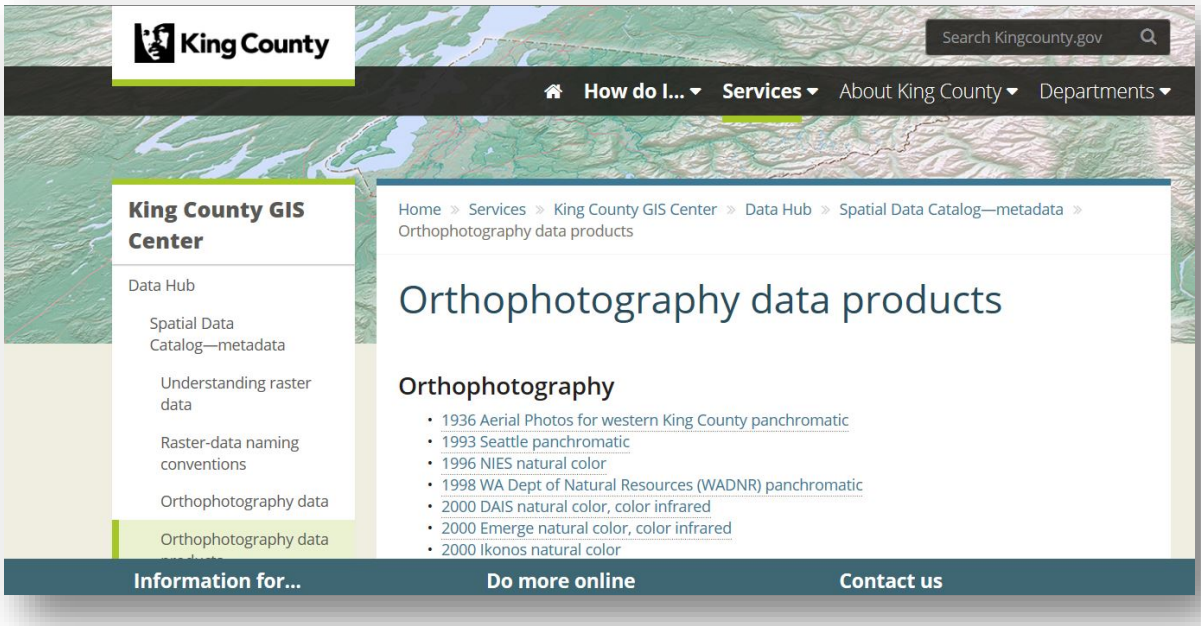

Table 2. King County Profile

Program Funding and Costs	
Funding sources	The program is funded through a group of participants in a variety of ways. Each participant signed a Funding Agreement and MOU with King County. The County uses a cost sharing approach. Larger cities like Seattle get the data for half price plus an administrative fee charged by the county on the order of 15%.
Annual costs and per square mile cost	The total cost of the project in 2015 $1.5 million. Acquisition cost was approximately $490/square mile.
Staffing	
Administrative	One manager from the City of Seattle and one GIS Manager from the county, plus the vendor, GeoTerra, provided project management. A Technical Manager provided by the vendor sorted costs for each participant based on the size of their area of interest, organized a lot of the technical aspects including QA/QC efforts, communicated the schedule of each aspect of the project, and handled delivery of the data to each participant.
Technical	No technical staff were dedicated full-time by King County for QA/QC. However, review of the imagery was provided for the County and partners by the vendor using an ArcGIS online portal. The vendor was responsible for QA/QC.
Other	A Project Manager ran sponsor group meetings and implemented funding agreements. Legal and executive staff were involved in the process at various times.
Stakeholders, Partners, Consortium	
Stakeholders and/or Partners	The recent 2015 project involved more than 100 partners. Participating entities include cities, counties, tribes, state/federal agencies, first responders, utility districts and private businesses. King County manages the imagery acquisition partnership. Each participant signed a Funding Agreement with the County and the County signed a Contract for Services with the vendor.
Consortium	A formal consortium organization is not established. The program is referred to as a group of partners. The program is similar, however, to the vendor-led consortium in Wisconsin. For example, the 2015 orthoimagery program was put out for contract, and the project was jointly managed by vendors in conjunction with King County GIS and the City of Seattle.

Determination of Business Needs	
Use Cases	No formally defined Use Cases.
Frequency of Imagery Acquisition and Procurement Methods	
Frequency of acquisition	A five-year contract with a vendor was established in 2016, and imagery acquisition will occur every two years.
Procurement Method	In Washington, imagery projects fall under Engineering/Surveying procurement laws so firms were evaluated and a vendor selected based on Statements of Qualifications. Costs for the project were then negotiated after the firm had been chosen.
Typical Size of Acquisition Area; Prioritization Method	
Acquisition Area Size	The 2015 project encompassed an area of western Washington spanning approximately 3,876 square miles. Typically, acquisition areas are smaller.
Prioritization method	Priority wasn't really established, one of the larger suburban cities recently had annexation and had projects waiting on imagery. This city was accommodated and got the earliest release.
Imagery Specifications	
Resolution	Rural areas: 1-foot pixel Urban areas: 3-inch pixel. Note: The contract originally called for accuracy specifications that were unclear and not industry standard. These were replaced with the 2014 ASPRS specifications.
Type of imagery	RGB orthoimagery.
LiDAR	
Part of the Program?	No, but LiDAR was acquired as part of the 2015 program and used to rectify the imagery.
Data Licensing, Fees, Distribution	
Licensing & Fees	Access to the LiDAR and imagery data is available in the public domain. Data distribution in the county is a team effort amongst partners, but is centrally distributed by King County.
Distribution	The data can be obtained by request from the King County website.

Keys to Success	
	Good working relationship between King County and the City of Seattle. Strong vendor relationship and commitment on the part of the vendor to the program.
Lessons Learned	
	Pre-acquisition planning is critical and should be reviewed closely. Getting commitments from all participants before signing a contract with the vendor is beneficial. Funding mechanisms vary widely and a change in administration can cause funding to change. Large projects can over-burden staff resources. A Digital Terrain Model (DTM) is needed to account for elevation warping, and ensure imagery accuracy. Survey control metadata is important. Control gathered from a number of the participants was generally of unknown age and reliability requiring last minute collection of survey control. There were challenges faced by the program including the need for consistent survey control, vertical/elevation data, and others. RFP generation takes time to do correctly. The 2015 RFP began development in 2012.

3.3 Puget Sound LiDAR Consortium

Program Overview

The Puget Sound LiDAR Consortium (PSLC) is a non-profit organization composed of more than 40 partners including local counties, state agencies, and others. Staffing consists of local agency staff and federal research scientists devoted to developing public-domain high-resolution LiDAR topography and derivative products for the Puget Sound region. The PSLC has been acquiring LiDAR data successfully for nearly 20 years in the Pacific Northwest.

Although the PSLC does not acquire aerial imagery, the program is applicable to aerial imagery in these regards:

- Both aerial imagery and LiDAR require similar airborne technologies, for example aircraft mounted with sensors and sophisticated processing methods.
- Both benefit from a recurring, regular established program.
- A regional consortium approach benefits multiple partners in terms of cost.
- Clearly defined technical specifications and contracting system.
- Strong project management, technical staff support, and a team approach.

The PSLC is a non-profit organization with a long history of successful regional LiDAR acquisitions. PSLC developed in the fall of 1999, with participants from Kitsap County, City of Seattle, Puget Sound Regional Council, NASA, and the USGS. Initially driven by the need to map geohazards (faults, landslides), the program has led to the use of LiDAR data for other applications. Figure 3 below shows the PSLC website highlighting the variety of its partner composition.

Figure 3. Puget Sound LiDAR Consortium Website

Table 3. Puget Sound LiDAR Consortium Profile

Program Funding and Costs	
Funding sources	The funding is from various sources. In 1999-2002 the USGS and several counties funded the acquisition programs. Cities and other organizations joined the consortium later.
Annual costs and per square mile cost (where provided)	Current pricing is $500/square mile for high resolution LiDAR (8 pulse/m2). The consortium splits billing by area or other criteria to the multiple consortium jurisdictions.
Staffing	
Administrative	The salaries and expenses of team staff have not been directly funded. Internally, PSLC is staffed with: 1 coordinator, hours based on need. 1 contract administrator, hours according to project need. Project management is delegated mostly to the vendor, are budgeted in the project at 7 percent.
Technical	1 internal project QA/QC, assigned hours based on project size 1 system administrator, minimum time volunteered (University of Washington) QA/QC costs are budgeted at 7 percent in the project budget. Team staff participates in QA/QC.
Other	Partners contribute staff and expertise to the projects.
Stakeholders, Partners, Consortium	
Stakeholders and/or Partners	The PSLC is a consortium composed of 40 partners and includes major local governments such as City of Seattle, King County and Kitsap County. A group of more than 40 partners has signed an MOU (see Appendix C) and participates in review and development of specifications (see Appendix B).
Consortium	Yes.

Determination of Business Needs	
Use Cases	The driving business need at the early stage of this program was the need to map geohazards. The geohazard Use Case became the major Use Case after the discovery of fault zones near Seattle with LiDAR. Since then, two other key Use Cases have emerged: tree stand mapping and landslides.
Frequency of Imagery Acquisition and Procurement Methods	
Frequency of acquisition	The PSLC does not determine LiDAR acquisition frequency. Each project acquisition is determined by the participating consortium members.
Procurement Method	The contract went through a competitive bid process during the spring of 2012. They carefully reviewed multiple proposals and then selected the top candidate. Their current vendor is Quantum Spatial.
Typical Size of Acquisition Area; Prioritization Method	
Acquisition Area Size	The acquisition size varies from local county to regional scope, and it is based on the demand for LiDAR, for example in 2016 there was only one project sized at 1,200 square miles.
Prioritization method	No method is employed for prioritization.
Imagery Specifications (note this is a LiDAR program)	
Resolution	8 pulse/meter^2.
Type of imagery	Intensity imagery is a derivative product.
LiDAR	
Part of the Program?	Yes.
Data Licensing, Fees, Distribution	
Licensing & Fees	Access to the imagery data is available in the public domain.
Distribution	Website access to data.

Keys to Success	
	Successful delivery of LiDAR data to partners over a long period of time, since 2000 due to well defined set of specifications, MOU, and vendor contract using long term contracts. Developed specifications well suited to consortium member needs. Developed an excellent working relationship with the contractor. Fixed prices create budget certainty for consortium members. Excellent technical staff and team approach.
Lessons Learned	
	Need a well-defined specification. Regular updates of specifications, and consideration of new technology. Utilize a “keep it simple” approach utilizing no frills MOU, contract, and specifications that remain consistent over a multi-year period.

3.4 Spokane County

Program Overview

The Spokane Area Orthophotography & Oblique Imagery program is primarily funded by three major parties; two public, the City of Spokane and Spokane County and one private utility, Avista Utilities. The primary partners share costs equally and fly the entire County once every other year. These three entities are bound together via an interlocal agreement with Spokane County as the lead having the actual contractual agreement with the imagery vendor.

Sub-area partners (called 4th parties) are allowed to license the imagery for their specific service area. They are charged 25 percent of the actual cost of the imagery. Approximately 10-12 fourth parties on average partner for a given acquisition. Because the actual spatial footprint of the fourth parties is relatively small they only generate a small part of the revenues needed (in the range of $20,000) per flight. All of the revenues are then cost shared back to the three primary funding partners equally. Examples of fourth party partners are universities, small municipalities, water and sewer districts, and the local air force base.

A core group of county departments contributes most of the imagery funding. The department that derives the most benefit has been the County's Assessors office for property appraisal and that has been primarily due to the addition of high resolution oblique photography that helps facilitate accurate and up-to-date property assessment. This has been beneficial and led to the department greatly improving efficiencies gained through the use of imagery for annual property assessment. Spokane County's Sherriff Office is the other key funding partner. The Sherriff Office recently upgraded to a new Computer Aided Dispatch system that now allows for viewing of orthoimagery and oblique imagery, and this is used extensively. Imagery is increasingly used by these departments as a web imagery service that is easily integrated into the CAMA tax appraisal system and dispatch system, and imagery will be looked at as an essential product down the road.

The next level of City and County departments that benefits from aerial orthoimagery and oblique imagery is development services/planning and particularly permitting activities. The Engineering and Utility Departments also benefit but not nearly the level of the Assessors or Planning Departments.

The current Spokane County region-wide program has been in place since 2010 (necessitated because of the addition of oblique imagery). However, the program is rooted in a prior program that operated for 20 years and was managed by Avista Utilities. Program management is by the Spokane County GIS, with strong technical support for acquisition and imagery use provided by the vendor.

Table 4. Spokane County Orthoimagery Program Profile

Program Funding and Costs	
Funding sources	The program is funded by Spokane County, two cities and private utilities. These entities are bound together via an inter-local agreement with Spokane County as the lead having the actual contractual agreement with the ortho/oblique vendor. Spokane County users are charged for imagery on a computer-by-computer basis.
Annual costs and per square mile cost	The program is funded at $2.1 million annually. Costs per square mile for imagery have not been provided by Spokane County. Spokane County is approximately 1,700 square miles in area.
Staffing	
Administrative	Spokane County GIS manager. Most of this person's salary is funded by two of the consortium's partners.
Technical	The Spokane GIS staff assists in the imagery review, but primarily the imagery is processed and delivered to the County by the vendor. Technical review of the imagery is done via an online portal set up by the vendor and Spokane GIS in which program partners can review the imagery prior to delivery.
Stakeholders, Partners, Consortium	
Stakeholders and/or Partners	The Spokane Orthophoto Program is not a formal consortium by name, but Spokane County refers to their program as a "consortium." The following are key stakeholders in the program: • Public Safety • Utilities • Property Appraisal • City of Spokane • City of Spokane Valley 16 other partners fund the program at a lesser percentage.
Consortium	The program is essentially a consortium, but not called that.
Determination of Business Needs	
Use Cases	No formal Use Cases have been defined; however, the use of imagery by key partners such as the county appraisal department is well documented and publicized; and has helped in the program's success.

Frequency of Imagery Acquisition and Procurement Methods	
Frequency of acquisition	Urban as requested: 2-3 year cycles. Rural as requested: 3-5 year cycles Regionally, acquire imagery for the entire County once every other year.
Procurement Method	The County now has a 6-year contract established for the acquisition of imagery.
Typical Size of Acquisition Area; Prioritization Method	
Acquisition Area Size	Typically 100 to 500 square miles, with 5-year county-wide acquisitions.
Prioritization method	No prioritization method is employed.
Imagery Specifications	
Resolution	Urban: 4-inch pixel; Rural: 9-inch pixel
Type of imagery	The types of imagery captured are ortho and 4-way oblique imagery.
LiDAR	
Part of the Program?	Not a priority of the program; however, a cooperative program with USGS has in the past five years acquired county wide QL2 resolution data, and in 2015 acquired QL1 data for the Spokane City area.
Data Licensing, Fees, Distribution	
Licensing & Fees	Access to the imagery data is available in the public domain.
Distribution	The data can be obtained by request from the Spokane County GIS website. Online imagery services are provided by the vendor on a fee basis; and is utilized by partner cities, and some county departments. Imagery data is tiled and provided either as tile or as orthoimagery mosaic.

Keys to Success	
	Connection to the political process at highest local levels, e.g. Mayor. A strong emphasis on marketing of the imagery benefits. Demonstration of benefits, and delivery of high quality data. Funding by three major partners who are strongly vested in GIS and data acquisition to support that. High resolution and quality of the imagery suiting key stakeholders The establishment of a predictable recurring program Imagery has been integrated into business systems (CAMA, Permitting, Computer Aided Dispatch, etc.) improving the efficiency of existing business processes being performed by City and County staff.
Lessons Learned	
	Deliver data on time and with the highest quality, and set realistic expectations. Stay attuned politically to ensure funding is available for the program. Implement a strong technical program allied with a good vendor. Technology advances are greatly improving data acquisition, processing, and distribution.

3.5 Maine Orthoimagery Program

Program Overview

The Maine Orthoimagery Program is part of the Maine GIS office (MEGIS) which is legislatively mandated as the entity to manage statewide geospatial data and services, and to coordinate such activities with other organizations to lower overall costs for geospatial data and services. This program helps communities achieve great savings in the acquisition of orthoimagery. A driving reason for the program is to provide a framework for small communities to acquire imagery. Many small towns in Maine cannot afford orthoimagery. The previous method of piecemeal acquisition led to haves and have nots, higher overall costs, varying quality, duplication of effort, and a patchwork of products. Currently, the Maine program is very successful in delivery of imagery products to its partners and has recently initiated a statewide LiDAR program with USGS funding.

The MEGIS is an organization within the State of Maine's Office of Information, in the Department of Administrative and Financial Services. MEGIS provides key mapping services to state employees, citizens, and the geospatial community. MEGIS won the Esri Special Achievement in GIS award in 2013, due in part to their successful delivery of imagery data to a large number of Maine counties. MEGIS's core services include:

- Data Catalog
- Maine Aerial Photography
- Web Mapping Services

Also, provided by MEGIS are the following ancillary services:

- Maintenance of a public geospatial data portal
- Coordination of state efforts with federal and local efforts
- Development and maintenance of geospatial architecture (databases, servers) to provide robust mapping capabilities to state agencies and public-facing web services
- Maintenance of base data including town boundaries, hydrography, geographic names

The aerial imagery program began primarily in 2009, but was not firmly established as a recurring program until 2013. The reasons for this involve establishment of a strong county partnership which has taken time to evolve, as well as coordination with other agencies such as the USGS and FEMA who helped spur imagery acquisition programs in the past three to five years.

Business Needs were analyzed in 2013, and an extensive User Needs Survey was conducted. Please see Appendix A for a summary of Maine Use Cases developed from the survey.

Table 5. Maine Orthoimagery Program Profile

Program Funding and Costs	
Funding sources	County and state government. Large area contracting methods keep the cost to taxpayers as low as possible, improve the availability of standardized, high-quality products, permit more frequent updates, and ensure Maine residents have access to current orthoimagery for their community.
Annual costs and per square mile cost (where provided)	The proposal recommends buy-up options for groups of towns so they may purchase higher resolution orthoimagery. The cost for the statewide base program on a 5-year cycle is estimated to be on average $51/square miles, for a total of approximately $450,000 per year. State bond funds were matched by federal dollars to pay for the project. In 2012 the town of York experienced a savings of $26,000 over a previous acquisition in 2005 for the same quality data. Several other communities have documented saving over $20,000 each by participating in the program. Assuming an average savings of $20,000 for each community MEGIS projected a total savings of $1.5 million dollars.
Staffing	
Administrative	Executive Director leads the Orthoimagery Program, coordinates with partners, and oversees program administration. In 2017, the MEGIS consortium will begin a six-year program in which a contractor will lead the acquisition effort and provide technical services.
Technical	Three GIS technicians. They do not perform any formal QA/QC in house due to the specialty knowledge required, but do perform a limited amount of QA. The vendor provides most of the imagery technical support.
Stakeholders, Partners, Consortium	
Stakeholders and/or Partners	A total of 77 communities are stakeholders and partners in the Orthoimagery Consortium. Almost every county in Maine is now part of the consortium. The counties vary in geographic size, population density, and needs. The income differences between the counties are also great, with some of the more populous counties having larger financial resources to draw upon.
Consortium	Maine utilizes a consortium model that is similar to the Wisconsin Regional Orthophotography Consortium (Wisconsin) program. The consortium consists of a number of counties that sign an MOU and commit to buying imagery utilizing a common RFP and program as managed by the MEGIS. A total of 77 communities joined the MEGIS consortium over a period of five years including 12 counties.

Determination of Business Needs	
Use Cases	A survey was conducted as part of a Geospatial Strategic Plan developed in part with USGS funding in 2009 and updated in 2012. Results from the survey helped the MEGIS develop Use Cases as listed by the MEGIS. There were 75 respondents to the Survey and Use Cases were developed from the results.
Frequency of Imagery Acquisition and Procurement Methods	
Frequency of acquisition	In 2011 the Maine GeoLibrary's Orthoimagery Subcommittee developed a proposal for updating the states imagery in five year cycles, with two levels of detail: 2-foot pixel resolution in organized communities and 1-meter resolution in unorganized communities. The proposal divides the state into groups of towns with the timing of updates being determined by the estimated rate of change and development.
Procurement Method	An RFP was developed and a selection process ensued in which a vendor was selected. A contract is established with the vendor.
Typical Size of Acquisition Area; Prioritization Method	
Acquisition Area Size	Acquisition area sizes vary from small counties to large counties of 3,000 square miles. Regional acquisitions at approximately 25,000 square miles are planned in 2017 through 2021.
Prioritization method	No method is employed for prioritization.
Imagery Specifications	
Resolution	MEGIS uses the ASPRS Base Level Specification as a guideline, in addition to the following standards: Urban areas: 3 to 6-inch pixel resolution (varies by urban density). Rural areas: 1-foot pixel resolution. Note: rural areas may be acquired at 6-inch resolution as imagery prices have lowered due to consortium pricing and improving technology.
Type of imagery	RGB orthoimagery.

LiDAR	
Part of the Program?	Yes. A regional acquisition of LiDAR is proposed for 2017.
Data Licensing, Fees, Distribution	
Licensing & Fees	Access to the imagery data is available in the public domain.
Distribution	Distribution of data is via the MEGIS website.
Keys to Success	
	Strong marketing at conferences and community events. Emphasis on a clear and structured MOU. A well-defined RFQ that took more than a year to develop. Strong networking amongst county partners.
Lessons Learned	
	Vendor led consortium model works well for Maine program. Federal and state involvement in imagery acquisition tends to complicate and delay the imagery program; however, the partnership with USGS on the LiDAR acquisition program is working well.

3.6 Wisconsin Regional Orthoimagery Consortium

Program Overview

The Wisconsin Regional Orthoimagery Consortium (WROC) is a multi-entity group composed mostly of counties. The WROC was first established to serve central and northern Wisconsin counties, but has since expanded to a large portion of the state. The goal of the consortium is to build and sustain a multi-participant program to acquire digital orthoimagery and elevation data for counties throughout Wisconsin. The WROC approach brings a number of potential benefits to its members, including cost savings, specifications and standards support, coordinated data acquisitions, data sharing between members and partners, and project management. The local county funding model originally was a difficult one because the counties focused on their own individual acquisitions. The WROC has established a system for coordinating county geospatial funding, reducing separate and sometimes redundant acquisitions, and directing sufficient funding to address a large number of counties aerial imagery needs.

The Wisconsin program is complemented by two other key mapping agencies in Wisconsin: the "Wisconsin View" program, and the State Cartographer's Office. Both of these groups are composed of largely academic or State agency partners, and have played a role in helping the WROC develop.

The funding in the WROC program is focused on the local county level, and counties are given the authority to use a portion of state revenues allocated for geospatial needs. The Wisconsin Regional Planning Commission also plays an important role in assisting counties in procurement of geospatial data, and in coordinating with the WROC.

As an example of the WROC's success, in 2015, they successfully acquired 56,000 square miles of 6-inch pixel aerial imagery for more than 75 members of the consortium. Figure 4 below shows the Wisconsin website which contains a variety of useful information about the program.

Figure 4. Wisconsin Regional Orthoimagery Consortium Website

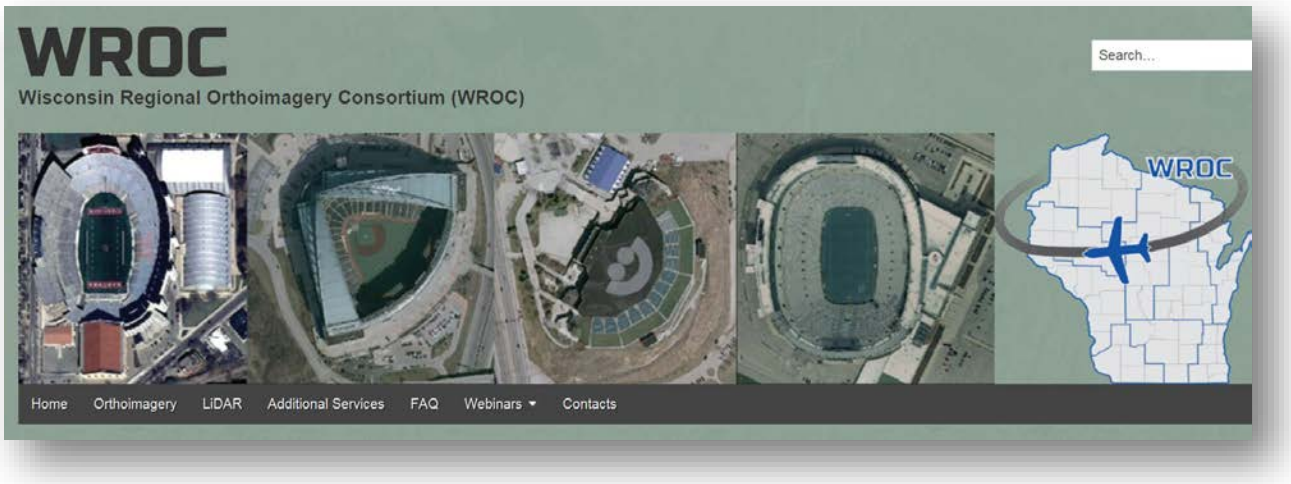

Table 6. Wisconsin Regional Orthoimagery Consortium Profile

Program Funding and Costs	
Funding sources	Counties, with some funding input from state and federal governments. The underlying base for funding of aerial imagery comes from the Wisconsin land information program which in turn derives its source revenue from standard fees that are part of property transactions. Each county receives funding from the State land program for imagery and other geospatial needs.
Annual costs and per square mile cost	Public and private organizations spend a combined average of $2.3 million annually on a wide variety of imagery projects. Typical aerial imagery acquisition costs through the WROC are $65/square mile.
Staffing	
Administrative	The WROC is a consortium managed by two vendors (Ayres Engineering and Quantum Spatial) who have the aerial imagery expertise and have well established local partners. Ayres Engineering and Quantum Spatial provide project management, training, some marketing, and technical resources. Note, a 15 percent extra charge is applied to WROC imagery costs to cover these services.
Technical	Provided by Quantum Spatial and Ayres Associates.
Other:	Staffing for Wisconsin, although largely vendor, is also provided by the Wisconsin Regional Planning Commission.
Stakeholders, Partners, Consortium	
Stakeholders and/or Partners	To date, almost exclusively county governments.
Consortium	Yes.
Determination of Business Needs	
Use Cases	Use Cases have not been defined in the Wisconsin program.
Other	

Frequency of Imagery Acquisition and Procurement Methods	
Frequency of acquisition	The approximate refresh cycle for Wisconsin imagery on average is every five years. This may vary as local counties may acquire imagery on a different schedule, and coordinate acquisitions. Typically, the urban communities such as Milwaukee, Green Bay, and Madison acquire imagery every two years, whereas rural communities such as Door County in the north acquire imagery on a five-year cycle.
Procurement Method	Imagery acquisition is procured through a Qualifications Based Selection (QBS) process. For a project of this type the WROC did not want to use a low-bid selection method. By using a QBS they would select the highest qualified firm to complete the project and the needs of consortium members.
Typical Size of Acquisition Area; Prioritization Method	
Acquisition Area Size	Given the variability in Wisconsin county sizes, the acquisition size varies, but typically has been in the 500 square mile range. The regional scope enlarged in 2015 when 40 counties acquired 6-inch resolution orthoimagery through Wisconsin over a 50,000 square mile area.
Prioritization method	None is used.
Imagery Specifications	
Resolution	All members acquired either 6 or 12-inch resolution, leaf-off imagery in prior acquisitions. There will be an 18-inch DOQQ dataset that will be put into the public domain in the fall of 2016. In general, the base product specification used by Wisconsin is ASPRS Class 2 and includes technical specifications for color balancing, sun angle, and other. A specification for 3 to 6-inch pixel in urban areas, and 1-foot in rural areas is being considered.
Type of imagery	RGB orthoimagery.
LiDAR	
Part of the Program?	Yes. In 2011, a large block of counties in Wisconsin completed LiDAR projects under the Wisconsin program. From 2014 to 2016, 20 counties throughout Wisconsin acquired LiDAR based on the success of prior projects and the benefits of high accuracy elevation data for local governments and the public.

Data Licensing, Fees, Distribution	
Licensing & Fees	Currently, the data distribution policy in Wisconsin (WROC and others) varies amongst counties, with some data being public domain, while a few counties are selling it. The trend in the past couple of years has been towards public domain data**.**
Distribution	Data distribution is provided using the WROC website, or through local planning commission offices.
Keys to Success	
	Establishing performance standards in delivery and quality. Establishment of a clear business operational model that is clear and straightforward. Technical support provided by the managing vendors has been very helpful. Most counties don't want to spend the time to analyze in detail the technicalities of imagery.
Lessons Learned	
	Vendor model works well for a consortium, but the vendor has to be trustworthy, know the territory, and clearly vested in the region. Plan ahead. It takes time to pull partnerships together, e.g. different fiscal years. Specifications are very important. It is important to spell out what, when, and at what cost. Make it equitable for all the partners, justify any differences in cost between them. Be mindful how partners get treated, and develop a trusting relationship with each. Partnership model gets complicated when State and Federal agencies get involved. It creates more complications in the process and maintaining the schedule. Find a good project management team. Having a program in place enables one to take advantage of opportunities more quickly

3.7 Arkansas GIS Office

Program Overview

The Arkansas County aerial photography datasets contains natural color imagery from the National Agriculture Imagery Program (NAIP). NAIP acquires digital orthoimagery during the agricultural growing seasons in the continental U.S. NAIP projects are contracted each year based upon available funding and the FSA imagery acquisition cycle. Although the program is almost entirely NAIP-based, there is strong state support and involvement in the program.

The Arkansas GIS Office's goal is to coordinate, publish and promote the best GIS data possible for Arkansas. The GIS Office integrated the Arkansas Spatial Data Infrastructure (ASDI) — previously known as" GeoStor" — into the GIS Office's website.

Arkansas's program began primarily in 2012. Its main success is the leverage of NAIP imagery so that counties can make use of it and that it is collected on a regular basis. They have also developed a very close partnership with the NAIP program and federal sponsors.

Table 7. Arkansas Orthoimagery Program Profile

Program Funding and Costs	
Funding source	State and federal government.
Annual costs and per square mile cost	Annual costs are approximately $1.1 million for orthoimagery acquisition through the NAIP. The Arkansas GIS Office manages and coordinates imagery distribution statewide. Arkansas is approximately 53,000 square miles in area.
Staffing	
Administrative	The GIS Office manager coordinates with the Federal NAIP on imagery needs and acquisition.
Technical	The Arkansas GIS Office consists of a staff of 10 geospatial personnel. None of them are dedicated to imagery, but do have a close relationship with the NAIP program and NRCS personnel.
Stakeholders, Partners, Consortium	
Stakeholders and/or Partners	State agencies and Federal agencies.
Consortium	No.

Determination of Business Needs	
Use Cases	Use Cases are not formally defined.
Frequency of Imagery Acquisition and Procurement Methods	
Frequency of acquisition	Beginning in 2003, NAIP was acquired on a 5-year cycle in Arkansas. 2008 was a transition year, and a three-year cycle began in 2009 which has continued.
Procurement Method	Uses the NAIP procurement contracts. Imagery is procured from NRCS utilizing their program. Procurement is conducted independently of each agency.
Staffing	
Administrative	The Arkansas GIS Office manager coordinates with the Federal NAIP on imagery needs and acquisition.
Technical	The Arkansas GIS Office consists of a staff of 10 geospatial personnel. None of them are technically focused on imagery, but do have a close relationship with the NAIP program and NRCS personnel. The Arkansas GIS Office provides technical staff to assist with imagery selection and coordinates with NRCS personnel.
Stakeholders, Partners, Consortium	
Stakeholders and/or Partners	State agencies and Federal agencies.
Consortium	No.
Determination of Business Needs	
Use Cases	Use Cases are not formally defined.
Typical Size of Acquisition Area; Prioritization Method	
Acquisition Area Size	Varies and follows NAIP protocols.

Prioritization method	NRCS and Arkansas GIS Office coordinate to determine priority acquisition areas.
Imagery Specifications	
Resolution	NAIP specifications include 1-meter pixel resolution. Arkansas NAIP imagery is acquired at a one-meter pixel resolution with a horizontal accuracy that matches within six meters of photo-identifiable ground control points, which are used during image inspection. Contractually, the requirement is a specification of no more than 10 percent cloud cover per quarter quad tile, weather conditions permitting. All imagery is inspected for horizontal accuracy and tonal quality. The NAIP product on a statewide level provides 2-meter GSD orthoimagery rectified to within +/- 10 meters of reference DOQQs.
Type of imagery	RGB orthoimagery. The default spectral resolution is natural color (red, green and blue, or RGB) but beginning in 2007, some states have been delivered with four bands of data: RGB and Near Infrared
LiDAR	
Part of the Program?	No.
Data Licensing, Fees, Distribution	
Licensing & Fees	Access to the imagery data is available in the public domain. A primary goal of the NAIP program is to enable availability of orthoimagery to its stakeholders within one year of acquisition. The Arkansas GIS Office clearinghouse has been instrumental in ensuring this.
Distribution	Arkansas imagery consumers utilize the GIS Clearinghouse and DVD distribution for imagery.
Keys to Success	
	Strong coordination the Federal NAIP program. GIS Clearinghouse works well as imagery portal and data center.
Lessons Learned	
	NAIP support is essential to providing imagery as needed.

4 Resources

ARKANSAS

Document Description	File Name (see electronic deliverable for files)
Legislation establishing the aerial imagery program	arkansas_Act1511aerialprogram.pdf

Program Website: https://gis.arkansas.gov/?page_id=7749

KENTUCKY

Document Description	File Name (see electronic deliverable for files)
Business Needs	kentucky_AgencyUses.pdf
Data Licensing and Distribution	KyFromAboveDistributionPolicy.pdf

Program Website: **http://kygeonet.ky.gov/**

MAINE

Document Description:	File Name (see electronic deliverable for files)
Summary description	maineorthoimagery.pdf
Business Needs	Orthoimagery Subcommittee Report Appendices_ME .pdf
	Orthoimagery Subcommittee Report Final_me .pdf

Link to Survey Results: http://www.maine.gov/geolib/orthosurveyresults.htm
Website for Maine GIS Office: **http://www.maine.gov/megis/maps/**

WASHINGTON

Agency	Document Description	File Name (see electronic deliverable for files)
Puget Sound LiDAR Consortium	Costs	PSLC Rates.pdf
Spokane County, WA. and Spokane Valley City, WA.	Data Licensing and Distribution	13-253 Pictometry Imagery License Agreement.pdf
	LiDAR and hazards	http://geomaps.wr.usgs.gov/pacnw/resfzplr1.html

Washington State Geo-Portal Website: http://geography.wa.gov

King County Orthophotography Website:
http://www.kingcounty.gov/services/gis/GISData/metadata/Orthophotography.aspx

Wisconsin

Document Description	**File Name (see electronic deliverable for files)**
Wisconsin Regional Orthoimagery Consortium, 2015 Summary	Wisconsin_2015_One-Pager_Finalv1.1.pdf
Letter of Intent for Partners	Wisconsin2015LOI_Partner.docx

Websites:	
Wisconsin Regional Orthoimagery Consortium	http://www.ncwrpc.org/Wisconsin2015/
Wisconsin View Consortium	http://www.Wisconsinview.org/
Wisconsin Cartographer's Office	http://www.sco.wisc.edu/
Sea Grant Mapping	http://seagrant.wisc.edu/home/Topics/Maps.aspx
Ayres Associates	http://www.ayresassociates.com/
Wisconsin View Portal	http://relief.ersc.wisc.edu/wisconsinview/form.php
Wisconsin View Consortium	http://wisconsinview.ssec.wisc.edu/membership/

Additional Information:

State Cartographer's Office, 2014, "Wisconsin Aerial Imagery: A Blueprint for Moving the State Forward." It is also based on a report developed for the state of Wisconsin in 2013 by GeoPlanning Services of Orlando, Florida under FGDC Cooperative Agreement #G11AC20047

State Cartographer's Office, 2014, "Key Characteristics of a Proposed Wisconsin Aerial Imagery Program"

5 References

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Other Key References:

ASPRS Report to the U.S. Geological Survey on Digital Orthoimagery
PHOTOGRAMMETRIC ENGINEERING & REMOTE SENSING
November 23, 2005

Appendix A: Use Case Examples

Maine Imagery Use Cases

Bureau of Parks and Land	
Type of Organization	State government.
Benefits	Locating roads and abutters. Timber mapping, project preplanning, road changes, land use determination.
Cost Savings	Did not have to pay for imagery for a new project. Time saved to aid in finding parcels. Saves from having to ground truth features.
Needs	Mapping parks assets, land status, and right of way.
Portland Pipe Line Corporation	
Type of Organization	Private industry.
Benefits	High resolution imagery provides an excellent means for tracking developments and surrounding communities.
Cost Savings	Access to MEGIS imagery saves time in image searching, and can obviate a field inspection visit. Also helps in preparation of permit applications.
Needs	High resolution mapping of the land crossed by the pipeline and impacts. Maintaining the imagery up to date will be important for our uses.
Maine Department of Transportation (MEDOT)	
Type of Organization	State government agency.
Benefits	MEDOT uses this imagery to assist in many different activities from general references on paper maps and map images to a quality assurance tool in creating or maintaining various datasets.
Cost Savings	Allows an employee to find necessary information without having to travel to that physical location. Also aids in creating tools to help establish a common visual or spatial understanding with employees or external partners and customers.
Needs	Highly accurate orthoimagery that supports transportation infrastructure projects.

Maine Imagery Use Cases Cont…

Walter Wefel Surveying, Inc.	
Type of Organization	Private industry.
Benefits	Assists with organization of control points/ROW monuments; and development of the town cadastral layer.
Savings	Decreases time in the field. Better conceptualizing of deed lines, better understanding of shore land zone/riparian/wetland issues, better communication with client.
Needs	Good imagery to support preliminary survey with mobile device using Cadastral overlay on MEGIS' GIS data.

Kentucky Use Cases Examples

Kentucky Department of Fish and Wildlife Resources	
Type of Organization	State government agency.
Benefit:	Current aerial imagery, along with accurate elevation information, are important to develop products for both public users and professional biologists. Showing recent images allows the public to see where open fields, forest, and water features are located before coming to the area.
Cost Savings:	Sharing costs with KFA means the agency doesn't have to acquire the data on its own.
Needs	The agency has struggled to develop accurate habitat models for elk and black bear in eastern Kentucky because the existing elevation data is not accurate. Similarly, developing habitat models for non-game species, such as songbirds, requires a combination of elevation, slope, aspect, and recent aerial imagery.

Kentucky Use Cases Examples Cont…

Kentucky Infrastructure Authority	
Type of Organization	State Government agency.
Benefit	The development of high-resolution leaf-off imagery and accompanying elevation data will be of tremendous benefit to projects for which the Kentucky Infrastructure Authority provides funding resources. Having this data in a single standardized coordinate system will facilitate the development of CAD drawings that can easily be incorporated into the Statewide geographic information system. Currently, most information provided by engineers to the Kentucky Infrastructure Authority has not been developed in a standardized coordinate system, meaning a great deal of time and effort must be expended to bring as-built data into the State geospatial database while maintaining a reasonable, or even quantifiable degree of positional accuracy.
Cost Savings	The resolution and accuracy proposed for statewide imagery and elevation data will essentially zero-out costs that are currently being incurred for each water and wastewater project, particularly those involving distribution/collection line replacement and/or expansions. This will also eliminate the lag time incurred while survey and mapping data is collected and compiled for each project, thus expediting the entire design and construction process.
Needs	High resolution horizontal and vertical mapping and topographic data.
National Geodetic Survey	
Type of Organization	Federal government agency.
Benefit	The goal of the Kentucky Height Modernization project is to "provide a reliable and accurate infrastructure for elevation data that meets the needs of a broad spectrum of users and applications." The first achievement in reaching this goal was to build a network of Continuously Operating GPS Reference Stations (KY-CORS). KY-CORS provides the framework for LiDAR to accurately reference flight paths and perform data calibration. With these tools, they now have the ability to create an accurate elevation model.
Cost Savings	Saves on survey control costs in the region to support LiDAR acquisition.
Needs	Regional survey control network.

Kentucky Use Cases Examples Cont…

Abandoned Mine Lands	
Type of Organization	State government agency.
Benefit	Program provides high resolution imagery to identify complaint generated project sites. Higher resolution imagery is also used to scout for potential waste areas.
Savings	Newer high-resolution orthoimagery further lessens the need for additional overflights. High-resolution orthoimagery plus LiDAR help every project designed and saves costs having to acquire imagery and/or LiDAR for every project.
Needs	Track mining developments; scout for potential waste areas and get more coverage. Support engineering and mapping projects.

Appendix B: Contractual Documents Examples

MAINE

Document Description	File Name (see electronic deliverable for files)
Maine Orthophoto Program RFP	OIT RFP 201607146 OrthoImagery Acq Svcs-FINAL.pdf

WASHINGTON

Agency	Document Description:	File Name (see electronic deliverable for files)
Puget Sound LiDAR Consortium	LiDAR RFP model RFP addendum	LiDAR_RFP.pdf LiDAR_rfp_addendum.pdf
Spokane County	4th Party Agreement: This licensing agreement is for small 4th party customers that only want a portion of the imagery. It details costs and licensing restrictions for all flights that occur during the 6-year contract.	WA_Spokane_Agreement_4-20-16.pdf
	ILA: This 6-year contract lays out the payment requirements, licensing restrictions from the vendor and covers the termination process. Also details service fees.	ILAcountycityavistaV11.docx
	This is the vendor contract [WA-Spokane Agreement]: This is the 6 year GSA contract with Spokane County.	FourthPartyImageryAgreement2016_2021v6.docx

Wisconsin

Document Description	File Name (see electronic deliverable for files)
RFQ documents	WROC_RFQ_2015_Final112612.pdf WROC_RFQ_Process_2015_v1_w_att.pdf

Appendix C: Imagery Specifications Examples

STATE/AGENCY	**File Name (see electronic deliverable for files)**
Kentucky - Kentucky From Above	kentucky_Specs_OrthoPhoto_Production.pdf
Maine - Maine GIS Office	ortho base specifications_me_v4.pdf
Washington - Puget Sound LiDAR Consortium	PSLC_Technical_Specifications_withAppendices.pdf

Appendix D: Definition of Technical Terms

Aerial photography: A series of photographic images of the ground, taken at regular intervals from an airborne craft, such as an airplane.

American Society of Photogrammetry and Remote Sensing (ASPRS): A scientific association of specialists in the arts of imagery exploitation and photographic cartography.

Digital Elevation Model (DEM): A digital cartographic representation of the elevation of the land at regularly spaced intervals in x and y directions, using z values referenced to a common vertical datum.

Digital Terrain Model (DTM): A vector dataset composed of 3D breaklines and regularly spaced 3D mass points, typically created through stereo photogrammetry, that characterize the shape of the bare-earth terrain. Breaklines more precisely delineate linear features whose shape and location would otherwise be lost. A DTM is not a surface model; its component elements are discrete and not continuous; a TIN or DEM surface must be derived from the DTM.

Image Resolution: Describes the linear size that an image pixel or raster cell represents on the ground. Common resolutions are 3 inch, 6 inch, 1 foot, 1 meter, etc.

Geographic Information Systems (GIS): A GIS manages spatial and tabular data in one software system; and provides tools to store, retrieve, manage, display, and analyze various types of tabular and geospatial data including aerial imagery, LiDAR, and vector data.

Ground Sample Distance (GSD): The distance between two consecutive pixel centers measured on the ground. The bigger the value of the image GSD, the lower the spatial resolution of the image and the less visible details. GSD and pixel are often used interchangeably.

Light Imaging, Detection, And Ranging (LiDAR): An technology that uses a sensor to measure distance to a reflecting object by emitting timed pulses of light and measuring the time difference between the emission of a laser pulse and the reception of the pulse's reflection(s). The measured time interval for each reflection is converted to distance, which when combined with position and attitude information from GPS, IMU, and the instrument itself, allows the derivation of the 3D-point location of the reflecting target's location.

National Agriculture Imagery Program (NAIP): A program to acquire aerial imagery at one-meter pixel resolution during the agricultural growing seasons, mostly in the continental U.S.

Orthophotographs: Aerial photographs geometrically corrected to create uniform scale and to remove displacements caused by terrain relief, sensor distortion, and camera tilt.

Pictometry™: Pictometry is the name of a patented aerial image capture process that produces imagery showing the fronts and sides of buildings and other features. Images are captured by low-flying airplanes, depicting oblique and overhead perspectives of features. special software is needed to accurately determine objects' size and position on the maps.

Point Cloud: One of the fundamental types of geospatial data (others being vector and raster), a point cloud is a large set of three dimensional points, typically from a LiDAR collection.

Raster Data: One of the fundamental types of geospatial data (others being vector and point cloud), a raster is an array of cells (or pixels) that each contain a single piece of numeric information representative of the area covered by the cell.

Remote Sensing: The technology of acquiring multi-spectral information about the earth's surface and atmosphere using sensors mounted on airborne platform (planes, helicopter) or satellites.

Satellite images: Images taken from satellites, which orbit the earth at much higher altitudes than airplanes. Satellites use a variety of methods to produce images, including infrared, water vapor, and visible image technologies. Satellite imagery resolution varies from 30- centimeter pixel to 5 meter plus pixel in the commercial market.

Vector Data: One of the fundamental types of geospatial data (others being raster and point cloud), vectors include a variety of data structures that are geometrically described by x and y coordinates, and potentially z values. Vector data subtypes include points, lines, and polygons.

Vendor Led Consortium: A group of multiple entities (local government, agencies, and other) that have formed a partnership also called consortium, which is managed by a vendor. The vendor sets timelines for acquisition in coordination with the partners, oversees the imagery acquisition, and has responsibility for direction of the recurring acquisition program.

Appendix E: Comparison Matrix of the Programs

Program	Program Funding and Costs	Staffing	Type of Program Organization	Determination of Business Needs	Frequency of Imagery Acquisition and Procurement Methods	Typical Size of Acquisition Area; Prioritization Method	Imagery Specifications	LiDAR	Data Licensing, Fees, Distribution	Keys to Success	Lessons Learned
Kentucky From Above	Funding sources include all levels of governments as well as universities, but State agencies are main sources; Annual cost; Acquisition RFP is negotiated with vendor.	Program administered internally with budget allocated for project management. Partners and internal GIS staff provide QA/QC.	Partnership Program: 20 Stakeholders / Partners Acquisition program managed by KFA with vendor assistance	Strategic business planning; Use Case definitions	Frequency of acquisition; 5 years Procurement Method; Contract	Acquisition Area; Typically 200 square miles, but adopting more regional scope as program matures Prioritization Method; None employed	Resolution; Rural areas: 6" and 1' Urban areas: 3" pixel Type of Imagery; RGB orthoimagery	Yes.	Licensing and Fees; Basemap data is public Distribution; Data available online	Collective approach to acquisition is cost effective; Using specifications that exceed federal specifications	Multiple uses for data saves acquisition cost; Use Cases beneficial for defining specifications and for selling the program.
King County	Funding Sources are county and cities; Cost: County-wide project: $1,469,000 in 2015 (3,000 square miles)	Project management and technical support provided by vendor. Online tool provided by vendor for internal review. Third party QA/QC provided by additional vendor.	Partnership program: Over 100 Stakeholders formed partnership in 2015 project Vendor managed project	No business needs analysis; however, emphasis is put on communicating business benefits.	Frequency of acquisition; 2 years Procurement Method; Statements of Qualifications	Acquisition Area approximately 3,876 square miles in 2015 Prioritization Method; None employed	Resolution; Rural areas: 1' pixel, Urban areas: 3" pixel Type of Imagery; RGB orthoimagery	No.	Licensing and Fees; Basemap data is public Distribution; Data available from King County website	Strong vendor support of the program; Good working relationship with vendor	Pre-acquisition planning is critical; Survey control should be carefully considered; Third Party review is helpful
Puget Sound LiDAR Consortium	Funding Sources; USGS grants, counties, State, cities Cost: negotiated for long-term contracts; QA/QC and admin costs at 7% each	Project management and technical support provided by vendor. 14% overhead is added to each acquisition to cover these vendor costs. Third party QA/QC provided by partner technical resources.	Consortium composed of 40 partners; Contractual agreement with partners	No formally defined Use Cases; but prominent drivers have been geohazards mapping.	Frequency of acquisition determined by consortium. Procurement Method; Bid process	Acquisition Area; Regional scope and occasional project specific (1200 sq.miles in 2016) Prioritization Method; None employed	Resolution; 8 pulse/meter^2 Type of Imagery; Intensity imagery is a derivative product	Yes.	Licensing and Fees; Basemap data is public Distribution; Data accessible from website	Well-developed specifications and RFP; Excellent working relationship with contractor; Excellent partner team approach to securing resources	Update and refine specifications as technology changes.
Spokane County	Funding Sources are the County, cities, and public utilities; Annual cost; negotiated for multi-year contracts	Program administered internally by County GIS Manager with budget allocated in acquisition budget for project management. Quality assurance / Quality control (QA/QC) online review tools used extensively by internal staff.	Partnership program: 21 Stakeholders / Partners Contractual agreements with partners	No formal business needs analysis.	Frequency of acquisition; Rural: 3-5 year cycle, Urban: 2-3 year cycle Procurement Method; Contract	Acquisition Area varies from County-wide to city boundaries; Prioritization Method; None employed	Resolution; Rural areas: 9", Urban areas: 4" pixel Type of Imagery; Ortho and four-way oblique imagery	Ancillary acquisition to imagery program.	Licensing and Fees; Imagery and related data is available as public domain. Distribution; Data accessible from website	Imagery that meets key user needs; Embedding imagery usage in workflows; Recurring program based on agreements	Realistic expectations for data delivery and quality; Implement strong technical programs; New technology can improve data quality and access.
Maine Orthoimagery Program	Funding Sources; Counties, some cities/towns, and State government Annual cost; $450,000	Project management and technical support provided by vendor. Online tool provided by vendor for internal review. Third party QA/QC provided by additional vendor.	77 communities joined the MEGIS consortium over the past 5 years	Strategic business planning; Use Case definition	Frequency of acquisition; 5 years Procurement Method; Contract	Acquisition Area; Vary from small to large counties of regional scope of 3,000 square miles. Prioritization Method; None employed	Resolution; Rural areas: 12", Urban areas: 3" and 6" pixel Type of Imagery; RGB orthoimagery	Yes.	Licensing and Fees; Imagery and related data is available as public domain. Distribution; Data accessible from website	Strong Marketing at conferences and community events; Strong partner network; Clear and structured MOU and RFQ	Centrally coordinated program is effective; Vendor assistance in managing Consortium helpful.
Wisconsin Regional Orthoimagery Consortium	Funding Sources; Counties and State and Federal governments Annual cost; negotiated for multi-year contracts	Project management and technical support provided by vendor. Online tool provided by vendor for internal review. Third party QA/QC provided by additional vendor.	Consortium: Stakeholders/members consist of county governments Contractual agreements with partners	No formally defined Use Cases	Frequency of acquisition; 5 years Procurement Method; Vendor selection process	Acquisition Area; Typically 500 square miles Prioritization Method; None employed	Resolution; Currently 6" to 12" Type of Imagery; RGB orthoimagery	Yes.	Licensing and Fees; Imagery and related data is not consistently public domain. Some counties sell data. Distribution; Data accessible from website	Performance standards for delivery and quality; Clear business / operational model between agency and vendor; Collective approach to acquisition	Vendor for project management works well, Plan ahead, Specification definition, Justify cost differences
Arkansas GIS Office	Funding Sources; State and Federal government Annual cost; negotiated through NAIP	Project management and technical support provided by vendor as part of NAIP. Some technical; Arkansas GIS office	Stakeholders / Partners consist of State and Federal agencies No formal consortium	No formally defined Use Cases	Frequency of acquisition; 3 years Procurement Method; NAIP procurement contracts	Acquisition Area; Defined by NAIP protocols Prioritization Method; TBD by NRCS and Arkansas GIS office	Resolution 2m GSD rectified within +/- 10 m of reference DOQQs Type of Imagery; RGB orthoimagery	No.	Licensing and Fees; Imagery and related data is available as public domain. Distribution; Data accessible from website (clearinghouse)	Strong coordination with the Federal NAIP program; GIS Clearinghouse works well as imagery portal and distribution center.	NAIP support is essential to providing imagery as needed.