Bureau of Arms Control, Verification and Compliance
Office of Verification, Planning and Outreach

Project Title: ***The Feasibility of Mobile Computing for On-Site Inspections***

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Project Objectives

- To explore the feasibility of mobile applications to on-site inspections.
- Expected outcome was a feasibility analysis and report and proof of concept for two types of mobile applications (Google Glass and augmented reality).
- Objectives answered the following AVC Research and Development Needs:
  - To embrace arms control in the information age capabilities, and
  - To research mobile applications for arms control.

Project Participants

- Karl Horak, Sharon DeLand, Dianna Blair, Sandia National Laboratories (SNL)
  - Investigated potential uses and constraints
  - Interviews with SMEs
  - Develop small-scale field exercise to assess concepts

Acknowledgements
Dan Wurmser, Larry Denyer, Don Clagget and Mark Lavens

How might mobile devices be used?

Arms Control Inspection Activities

- Inspection notification;
- Pre-inspection planning;
- Travel logistics;
- Pre-inspection briefing;
- Inspection;
- Post-inspection briefing; and
- Inspection report writing and submission.

Example Mobile Platform Capabilities

- Display
- Wireless communication
- Cellular communication (GSM, CDMA)
- Sensors (Compass, magnetometer, accelerometer, etc.)
- Cameras (high resolution still and video)
- LED lights (camera flash, flashlight, etc.)
- Video playback and HDMI output
- Personal productivity software, Web browsers
- Hardware connectivity and expansion (USB and/or proprietary interfaces)

Use Cases

- Mobile Devices for Inspection Team Information Support
  - Planning
  - On-Site Inspection Support
- Measurement and Sampling
- Managed Access
- Training

Use Cases Discussed Potential Benefits and Limitations – both Host and Inspecting Party

Use Case	Potential Benefits	Potential Limitations
Inspection Team Information Support	Data capture and entry Photography and videography Inspection team tracking and orientation	Usability in outdoor settings (glare) Limitations on use in sensitive facilities
Measurement and Sampling	Step-by-step workflow to support detailed sampling processes Documentation of sampling activities 3-D surveying to rapidly generate digital models of interior spaces	Potential limitations on use in sensitive facilities
Managed Access	Alerts for approaching managed access areas Live video stream as substitute for managed access Dynamic shrouding or virtual redaction of video streams	Requires mechanism to provide secure, authenticated data channels
Training	Access to off-site instructors Live video of remote training facilities Training on complex procedures via augmented reality	

These are illustrative highlights ….

Impediments, Risks and Mitigations

Impediments / Risks

- Intrusiveness
- Potential to put non-treaty info at risk
- Lost signals and dead zones
- Managing data flow if communicating
- Battery life
- Information security / authentication

Host Operations

- Trusted operators could allow for more functionality
- Need to certify for safe, secure and trusted operation

Deployment Options

- Facility-owned and supplied equipment for hosts and/or inspectors
- Inspection Team-supplied mobile devices for their own use
- Inspection Team-supplied mobile devices for facility operator use during OSI

Inspector Operations

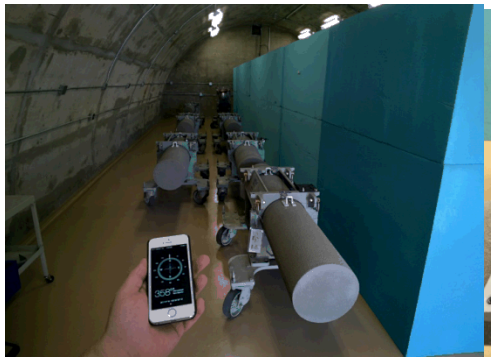
- Facility could require constraints on capabilities
- Information security needed
- Need to certify for safe, secure and trusted operation

Field Exercises – Surrogate Bunkers

The field exercise explored several different mobile computing capabilities and compared mobile-enabled activities to more traditional approaches

- Still photography
- Video recording of the entire inspection
- Location tracking with mobile devices
- Use of QR
- Managed access

Results

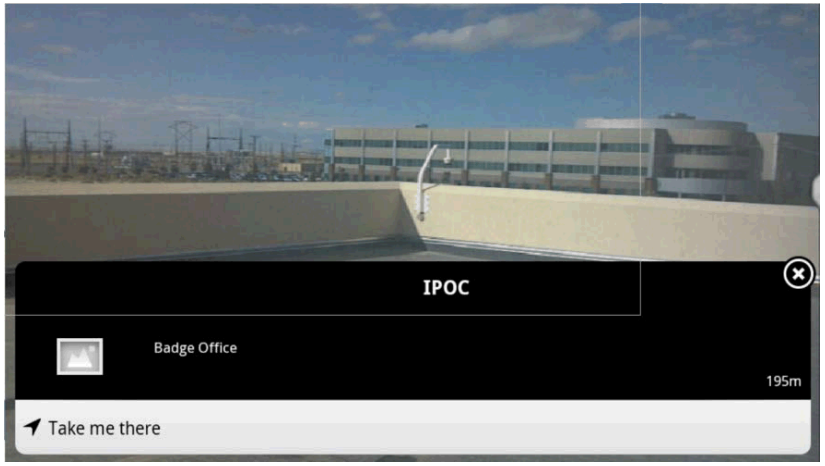


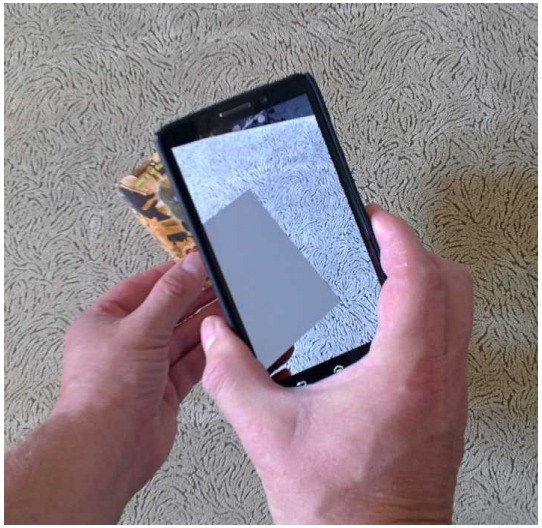
- Still photography
  - File storage feasible
  - Details (labels) may be hard to distinguish
- Video recording
  - File storage infeasible on mobile devices
  - Dedicated device (GoPro) feasible
- Location tracking
  - COTS GPS tracking program able to follow route with elevation, pace, timestamp
- QR Codes
  - Easily read
  - Links to external sources require data link
- Managed access
  - Data link issues hindered shared video
  - Used observed still photography instead; some limitations reviewing details in photos

GOTS/COTS apps were able to support inspection-related activities; did not necessarily outperform traditional methods in this limited exercise

Additional Concepts

Augmented Reality can support shape recognition; automatic linking of additional information





Dynamic, virtual shrouding

Mobile computing could enable virtual access to remote training facilities

Feasibility for Current and Future Treaties

- CTBT: Could assist with inspection –specific activities, equipment tracking, personnel management and safety considerations. Could be limited to on-board capabilities due to potential remoteness of sites
- FMCT: Inspections would likely encompass highly-sensitive facilities. Currently unlikely that mobile capabilities would be allowed.
- Strengthened Safeguards: Facility attachments have not accounted for rapid evolution of mobile computing
- Considerations for future treaties:
  - *Clear definition of allowable technologies with mechanism to update given rapid evolution*
  - *Allowable applications.* Verification and validation procedures, data transmission, information protection should be addressed.
  - *Clear delineation of areas of use*
  - *Telecommunication infrastructure.* Any site-specific telecommunications or networking infrastructure would need to be specified
  - *Pre- and post-inspection procedures*
  - *Clear statement of disallowed uses*
  - *Resolution of anomalies.*
  - *Contingencies for out-of-normal events*

Research Opportunities and Next Steps

Topic	Description
Information exchange mechanisms	Methods for verifying and authenticating jointly shared information
Quantitative comparison of potential information loss for telepresence versus physical inspections	If telepresence can be used in place of physical inspections, could reduce risk of information loss. Research to quantify difference could be useful
Mobile systems for OSI training and confidence building	Questions remain about the efficiency and effectiveness of mobile devices in various training environments. Existing devices should be formally evaluated
Limitations on allowable technologies	Technologies to automatically enforce restrictions on defined mobile capabilities within given areas could enable broader acceptance
Virtual shrouding and digital redaction	Refinement and vulnerability assessment of an augmented reality system to shroud objects under video surveillance
Formal requirements for mobile technologies in support of OSI for future treaties	To move forward, detailed specific requirements for use of mobile technology in OSI, developed with input from stakeholders

Project Implementation

- All deliverables were met and included:
  - Feasibility Analysis and Report
  - Proof of Concept for Two Types of Mobile Applications

- Challenges included:
  - Execution of proof of concepts.

Project Significance

- Connected to the exploration of arms control in the information age.
- Examined the uses and limitations of mobile applications balancing the capabilities increase in efficiency and effectiveness in inspections against the need to protect sensitivities at sites.
- Provided recommendations on issues and areas where mobile applications may be useful, where it may not be useful, and what further discussions will be needed on the topic.

Next Steps

- Project was a stand-alone to analyze the utility of mobile applications for on-site inspections in light of managed access issues.
- Report is publicly available on-line. http://prod.sandia.gov/techlib/access-control.cgi/2014/1418291.pd
- No other follow-on funding or transition was planned or expected.

Conclusions

- Project achieved its objectives to analyze feasibility, providing both the positives and negatives to mobile applications.

- Report analysis and summary is publicly available.

- Project
  - Addressed a direct AVC research and development need,
  - Explored an information age topic from the operational point of view, and
  - Resulted in recommendations that could guide other work

On-site Inspection Applets for Mobile Devices

Proposal Description:
Feasibility analysis and prototype development of safeguards/verification applets for OSI mobile devices

Partner(s)/Proposer(s):
Sandia National Laboratories

End User(s):
On-site inspectors; Inspected State parties (hosts & escorts)

Deliverables:
Feasibility report on mobile data and apps for OSI
Prototype QR code system for tracking inspectable items
Prototype field-deployable augmented reality system for OSI

Verification Technology R&D Need Objective:
On-site inspection makes heavy demands on inspectors and hosts alike. Mobile technology offers a means to leverage existing capabilities found within smartphones and tablet computers so that parties involved in an OSI event can manage information on-site in real-time.

Sandia proposes to conduct a feasibility study based on previous research into mobile applications for managed access under the Additional Protocol, CWC, a putative FMCT, and CTBT. Based on those findings, we will devise proof-of-concept prototypes for item tracking with QR codes by means of mobile devices and an augmented reality system to support real-time in the field facility inspection.

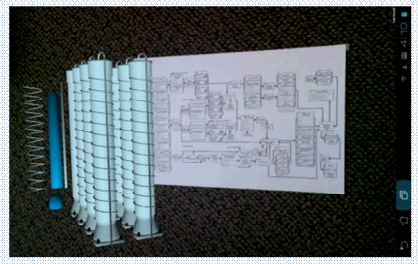
Cost:

Feasibility study	$45K
Report of findings	$10K
QR code tracking prototype	$20K
Augmented reality prototype	$15K
Final report and s/w demonstrations	$20K
	$110K

Schedule:

Feasibility study	Dec. 2013
Report of findings	Jan. 2014
QR code tracking prototype	Apr. 2014
Augmented reality prototype	June 2014
Final report/demonstrations	Sept. 2014

Noteworthy:
Horak, K. 2013. Mobile Information Technologies and Managed Access During On-site Inspections. European Safeguards R&D Assoc. (ESARDA) Symposium 2013.



Screen shot of an augmented reality app showing an 8 centrifuge cascade in relation to a nuclear weaponization process flow diagram.