

## Day 1 Introduction to workshop topic

### Agile Hardware Development Infrastructure/ConOps

*Rick Dove, Paradigm Shift Int'l, INCOSE Fellow. [rick.dove@parshift.com](mailto:rick.dove@parshift.com)*

An agile development infrastructure provides an architectural framework for component interconnect that enables asynchronous, incremental, and iterative component development. An agile hardware-development infrastructure would facilitate asynchronous component testing, alignment with agile soft-ware development, demonstrable and testable work-in-process of mixed component releases/prototypes/simulations, and operational system evolution. But hardware development is very different than software development. Agile software development relies on object-oriented infrastructure and web-page hyperlink couplings as architectural underpinnings. Soft-ware developers are simultaneously designers and fabricators, and incremental development lends itself to incremental test and demonstration. In contrast, hardware development has issues of tooling; communication between designers, fabricators, and assemblers; and costly re-work.

An agile approach is beneficial when development occurs under uncertainty, unpredictability, and situational evolution – requiring the application of incremental learning during development. What are the barriers to incremental and iterative hardware development? Can concepts from product-line engineering, open system architecture, or live-virtual-constructive approaches offer guidance? Are proprietary approaches the only avenue, or is there opportunity for affordable common development-platform tools?

This workshop will explore the values, the issues, and the requirements for possible solutions.

Rick Dove, INCOSE Fellow, was co-PI on the original work which identified Agility as the next competitive differentiator, in a 3-month industry-collaborative workshop funded by the US Office of the Secretary of Defense in 1991 at Lehigh University. He went on to organize and lead the US DARPA-funded industry collaborative research at Lehigh University's Agility Forum, developing fundamental understandings of what enables and characterizes system's agility.

He authored *Response Ability – The Language, Structure, and Culture of the Agile Enterprise*. He has employed these agile concepts in both system architecture and program management for large enterprise IT systems, for rapid manufacturing systems and services, and for self-organizing security strategies.

For Stevens Institute of Technology he teaches graduate courses in basic and advanced agile-systems and agile systems-engineering, at client sites. He is CEO/CTO of Paradigm Shift, an applied research firm specializing in agile systems concepts and education. He chairs the INCOSE working groups on Agile Systems and Systems engineering, and on Systems Security Engineering..



# **Workshop Intro**

## **Agile Hardware Development Infrastructure & ConOps Converging on Issues and Objectives**

**Socorro Systems Summit, 28-29 October 2016, New Mexico Tech, Socorro, NM**

**This session will be recorded for my private use, if that's OK with you.**

### **Hello!**

**My name is Rick Dove (moderator for this session)  
independent researcher and practitioner in agile systems engineering.**

**Adjunct professor at Stevens Institute of Technology for agile SE courses.**

**I'm interested in means for enabling hardware development agility,  
and what issues and barriers must be overcome to achieve that.**

**I'm here to understand the nature of your needs and issues,  
as you perceive and experience them in your environment.**

**I'd like to take away a broad and general understanding of the problem space,  
so I can discover and educate on addressing it effectively.**

**===== later =====**

**You will all introduce yourself similarly**

# **Session Purpose Today – 13:30-15:00**

**I provide some food for thought, about 30 minutes.**

**This thought will focus on the nature of the problem ... somewhat.**

**We share who's here and why.**

**Open discussion on perceived situation and issues.**

**We agree on a short list of issues and objectives to explore tomorrow.**

**At 14:00 we share interests**

**At 14:30 we converge on issues and objectives – a short list for tomorrow**

**At 14: 45 we construct our one-slide poster for tomorrow's focus**

**At 14:55 we have a hard stop**

# Agile HW-Development Infrastructure/ConOps

Moderator: Rick Dove

(as decided Friday, subject to change during Saturday)

## Planned Primary Workshop Issues to Explore

??

??

??

## Potential Secondary Workshop Issues to Explore

??

??

??

## Objectives

??

??

??

**You own this end-of-session deliverable**

# Value Proposition for Agility

**Faster, lower cost system development?**

**An appealing argument, but only a side effect (at best).**

**The value proposition for agility is Risk Management.**

**Sustainability of process and product at risk.**



**Why is incremental and iterative development useful?**

**Why are incremental retrospectives useful?**

**To learn about and mitigate risk affordably.**

# Sources of Risk

## CURVE

Internal and external environmental forces that impact process and product as systems

**Capriciousness:** unanticipated system-environment change  
Unknowable Situations

**Uncertainty:** kinetic and potential forces present in the system  
Randomness With Unknowable Probabilities

**Risk:** relevance of current system-dynamics understanding  
Randomness With Knowable Probabilities

**Variation:** temporal excursions on existing behavior attractor  
Knowable Variables And Associated Ranges

**Evolution:** experimentation and natural selection at work  
Gradual Successive Change

# Enabling Sustainable Agility

## Iconic Agile Architecture Pattern (AAP)

### System Response-Construction Kit

#### Modules/Components



Gears/Pulleys



Motors



Wheels



Tools



Joiners, Axles, Small Parts



Structural Material

#### Integrity Management

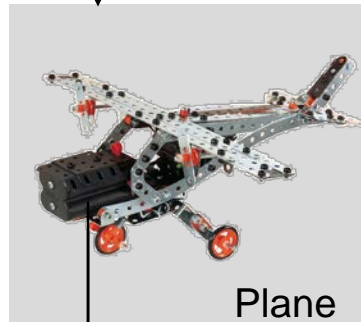
- Resource mix evolution
- Resource readiness
- Situational awareness
- Activity assembly
- Infrastructure evolution

- Product System Eng.
- Retail Distribution Process
- Product Manager
- Owner/Builder
- Product Manager

Active

#### Infrastructure

Passive



Plane



Helicopter



Mobile Radar

- Sockets
- Signals
- Security
- Safety
- Service

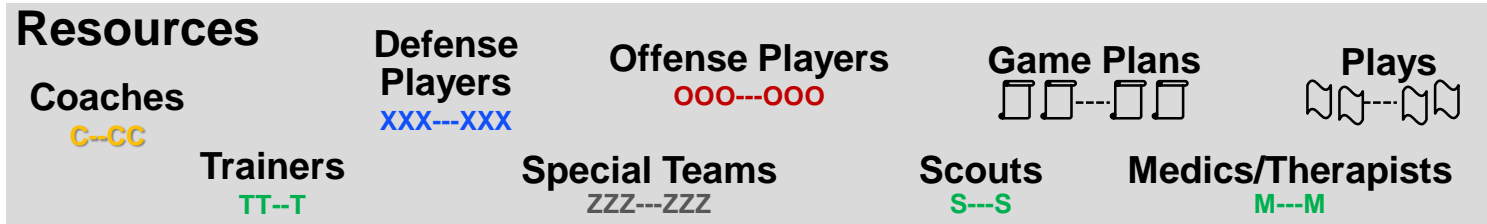
- Parts Interconnect Standards
- Construction stability (None)
- Harm-Proofing Standards
- Process Rules & ConOps

#### Rules/Standards



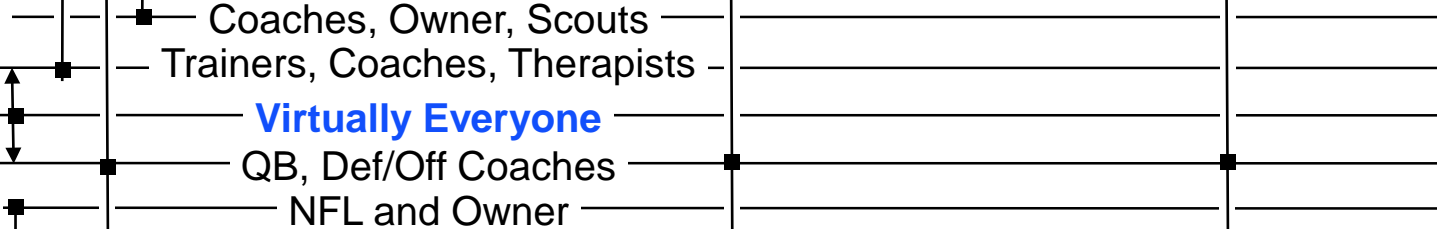
# Operating Process AAP for USA Football

Drag-and-drop resources in a plug-and-play infrastructure

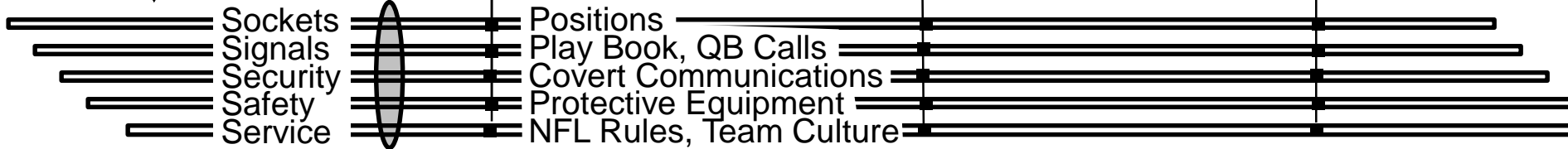
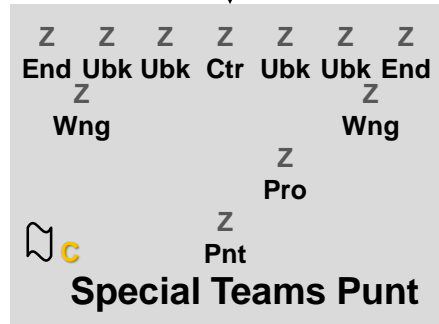
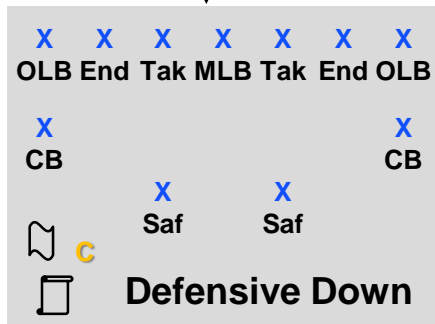
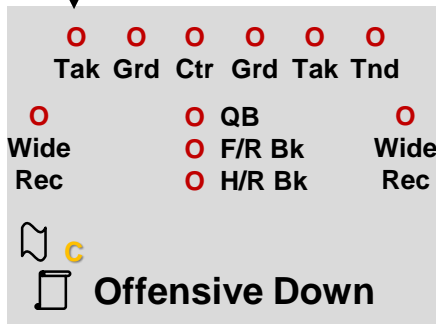
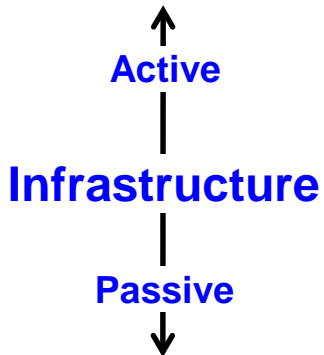


## Integrity Management

- Resource mix evolution
- Resource readiness
- Situational awareness
- Activity assembly
- Infrastructure evolution

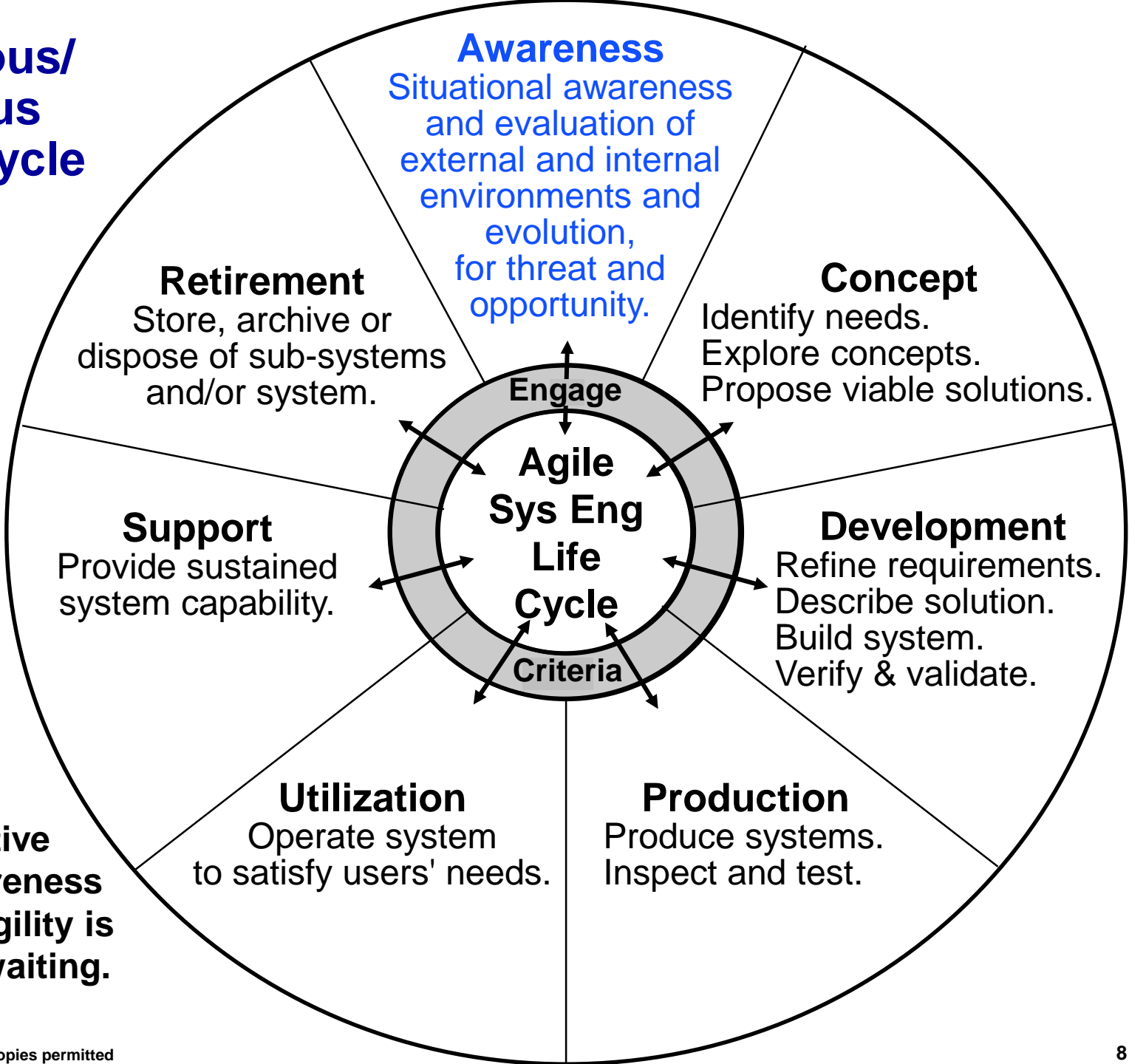


**Virtually Everyone**



(a concept example, not exhaustive)

# Asynchronous/ Simultaneous Agile Life-Cycle Framework



**Constant, effective situational awareness drives agility. Agility is a capability in waiting.**

# Both Process and Product Need AAP

Agile SE processes deal with changing knowledge and environment.

- They learn and employ that learning during SE process operation.
- They modify/augment product-development work-in-process.
- **The product's AAP enables affordable wip modification/augmentation.**

## Problem Context

Agile software development processes (silently) rely on product AAP.

- Program code development employs an object-oriented AAP development platform (e.g., C++, Java, Eclipse).
- Web code development employs a loosely-coupled modular AAP inherent with hyperlinked web-pages.

Agile hardware development doesn't have off-the-shelf AAP tools.

- Proprietary product-line-engineering employs AAP.
- Proprietary Open System Architecture (OSA) employs AAP.
- Proprietary Live-Virtual-Constructive platforms employ AAP.

# Some Perceived Problem Issues

**Attitude: Agile what? That may work for software, but not for hardware!**

**Irrelevance: The Agile Manifesto doesn't address the real agility issues!**

**Systems are mixed hardware and software with different teams.**

**Hardware doesn't lend itself to iterative development.**

**Hardware and software with different timelines.**

**Subcontractors with different timelines.**

**Synchronized integration and test.**

**Tooling time and rework.**

**Designer and fabricator are different people with documentation interface.**

**Disparate teams with different personal & organizational missions & cultures.**

**Contract incompatibility.**

**Subcontractors on waterfall.**

**Cultural and procedural inertia.**

**No common/standard infrastructure development platform (like software has)**

OSA: Open System Architecture  
PDR: Preliminary Design Review  
CDR: Critical Design Review

# Examples

LVC: Live/Virtual/Constructive  
COTS: Common Off the Shelf  
SIL: System Integration Lab

- Flexis LVC (Live/Virtual/Constructive) environment at General Motors, circa 1980s**
  - Asynchronous development testing of factory device and control**
- GM JIT Assembly Lines – short run production after-market needs**
  - Product Line Approach (reusable/reconfigurable manufacturing modules)**
- SpaWar SC-Pac – six month incremental HW/SW autonomous vehicle releases**
  - OSA and cross-platform product-line concept**
  - Instrumented product-evolution integration testing for emergent conflicts**
  - Subcontractor development, contractor owns architecture & integration**
  - Full integrated-team mission alignment and information sharing**
  - Wave process model decouples development from integration & test**
  - Iterative integration & test with work-in-process**
  - Feature shall requirements written after acceptable working test**
  - Contract agility alignment and support, with integrated PDR/CDR**
- Lockheed: six month HW/SW aircraft weapon-system releases**
  - Product OSA and cross-platform product-line concept**
  - HW/SW asynchronous-delivery alignment**
  - Subcontractors responsible for development and integration & test**
  - Process instrumentation to optimize flow for development and test**
  - LVC-like SIL: interim low fidelity COTS, simulation, & evolving software**
  - Information debt monitoring/mitigation for sustaining operational service**
  - Contract agility alignment and support, with integrated PDR/CDR**

# Hello?

**What is your name and affiliation?**

**What do you do?**

**What is your general interest in this area?**

**Why are you in this session, what do you want discussed?**

**What would you like to take away tomorrow?**

# Suggested Objectives

**Something actionable to take away**

**What is the compelling value proposition for HW development agility?**

**What organizational and other barriers stand in the way?**

**What general requirements would barrier-elimination have to address?**

**Good ideas on what oughta be done  
have to first address the reality barriers,  
else ... acceptance and implementation is doomed.**

# **Agile HW-Development Infrastructure & ConOps**

**Moderator: Rick Dove**

**Day-1 Brief Out (as decided Friday, subject to change during Saturday)**

## **Planned Primary Workshop Issues to Explore**

- **Cultural inertia to accepting an agile HW approach**
- **Customer learning engagement**
- **Modularity purpose/intent/need**

## **Objectives**

- **Compelling value proposition for each issue**
- **Barriers to overcome in each issue**
- **Requirements that acceptable solutions must address in each issue**



# **Agile HW-Development Infrastructure & ConOps**

**Moderator: Rick Dove**

**Day-2 Brief Out**

**(as re-decided Saturday)**

## **Discussion Points**

- **Cultural Inertia**
- **Compelling Value Proposition**
- **Synchronized Customer Learning**
- **Modular Discussion**

## **Planned Primary Workshop Issues to Explore**

- **Cultural inertia to accepting an agile HW approach**
- **Customer learning engagement**
- **Modularity purpose/intent/need**

## **Objectives**

- **Impediments to overcome in each issue**
- **Compelling value proposition for each issue**
- **Requirements for acceptable solutions**

# Cultural inertia to accepting an agile HW approach

- **Impediments:**
  - **The way some people are**
  - **Complexity of agile HW development**
  - **Presumption that everyone has to change**
  - **Misunderstanding of Definition or Core Concepts of Agile**
  - **How to apply Agile Concepts in a hardware environment**
- **Compelling value proposition:**
  - **(A strategy for product line engineering benefit realization)**
- **Requirements for acceptable solutions:**
  - **Demonstrable value proposition**

# Obtaining synchronized customer learning engagement

- **Impediments:**
  - **Customer availability**
  - **Contract compatibility**
- **Compelling value proposition:**
  - **Increased customer service/satisfaction/ROI**
- **Requirements for acceptable solutions:**
  - **Universal buy in (across all stakeholders)**
  - **Demonstrate compelling value proposition**

# Having an agile process requires an agile product/design

- **Impediments:**
  - **Inappropriate architecture**
  - **Inappropriate infrastructure**
  - **Inappropriate production environment**
  - **Inappropriate supply chain**
- **Compelling value proposition:**
  - **Implementable process learning produces a better product**
- **Requirements for acceptable solutions:**
  - **Capable, affordable development of agile infrastructure**
  - **Alignment of supply chain**
  - **Product design for sufficient agility**
  - **Adaptive production environment**

## Agile Hardware Development Infrastructure/ConOps

October 29 Attendees

	Name		Affiliation	email
1	Rick	Dove	Paradigm Shift International	<a href="mailto:dove@parshift.com">dove@parshift.com</a>
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3	Elena	Antuñano	Northrop Grumman	<a href="mailto:elena.antunano@ngc.com">elena.antunano@ngc.com</a>
4	Ed	Carroll	Sandia	<a href="mailto:ercarro@sandia.gov">ercarro@sandia.gov</a>
5	Nathan	DeVilbiss	ATA-Aerospace	<a href="mailto:nathan_devilbiss@msn.com">nathan_devilbiss@msn.com</a>
6	bandit	Gangwere	XL Scientific	<a href="mailto:bandit@cruzio.com">bandit@cruzio.com</a>
7	Rick	Kennedy	Kennedy Solutions	<a href="mailto:rkennedy@kennedysolutionsllc.com">rkennedy@kennedysolutionsllc.com</a>
8	Paul	McGoey	Himself	<a href="mailto:pjmgoey@comcast.net">pjmgoey@comcast.net</a>
9	Christopher	McLaughlin	National Radio Astronomy Observatory	<a href="mailto:cmclaugh@nrao.edu">cmclaugh@nrao.edu</a>
10	Jack	Ring	Educe LLC	<a href="mailto:jring7@gmail.com">jring7@gmail.com</a>
11	Bill	Schindel	ICTT System Sciences (facilitator)	<a href="mailto:schindel@icct.com">schindel@icct.com</a>
12	Malachi	Rademaker	New Mexico Tech (session support)	<a href="mailto:malachi.rademaker@student.nmt.edu">malachi.rademaker@student.nmt.edu</a>