Harrisburg Connected Corridor

Concept of Operations Briefing Summary

Brian Reed, Manager Applied Technology (WSP)

WO04 –Key Task Components

- Harrisburg Connected Corridor Workshops & Exercises
  - *Evaluation of CAV and Project Needs and Priorities*
  - *Data Analysis*
- Harrisburg Connected Corridor Concept Planning
  - *PTC CAV Priority Applications definitions*
  - *Network and Security High Level Architectures*
  - *High Level System Architecture*
  - *CAV Priority Application Architecture revisions*
- Harrisburg Connected Corridor Priority Application Use Cases
- Concept of Operation "Document"
  - *Background -Justification, State of Market, Needs, Priorities, Risks, Costs, Recommendations*
- Tracking and updates for Market Factors and OEM Positions
- Executive Briefing

WO05 –Key Task Components Completed

- Security Management Operational Concept
  - *Risk & Mitigation Summaries by PTC Priority Application*
  - *Network High Level Architecture*
  - *Draft System Architecture*
- Data Governance &Management Plan
- Technology Review White Paper
- Executive Briefing
- Security Vision “Document”

Key HCCS Decisions (to date)

- Add a secondary ISP link for "CV data"
- Add/use separate router at head-end (ISR –type device) for CV
- Add/use Commercial SCMS production certificates
  - *IP4/IP6 network setup for OBUs and RSUs*
- Add/use separate packet inspection/firewall (ASA –type device) for CV
  - *New & separate VLAN for CV field devices for Harrisburg Connected Corridor*
- Phase 1deployment - utilize separate cellmodem comms
  - *Requires end to end delivery of IP4/IP6*
  - *Routing from site through net to head -end router/firewall*
  - *Utilize until fiber in place per ITS/CV site*
- Priority Applications
  - *Curve Speed Warning,*
  - *Reduced Speed -Congestion Warning,*
  - *Queue Warning,*
  - *Spot Weather Warning*
  - *Work Zone Warning -Notification,*
  - *Incident Management Warning -Notification*
- Message-sets by PSID to implement
  - *WSA, WRA/PDM, BSM (Part 1 + Part 2), PVD, TIM -CSW, TIM-RSA, TIM-WEA, TIM-WZ, TIM-Qwarn /RSA, TIM-INC*

State of the Market –Summary

- National Highway Transportation Safety Administration (NHTSA)
  - *No rulemaking or formal policy ("yet") –timeline unknown*
- The Big Elephant in the room - FCC draft NPRM
  - *Dissolution of a portion of 5.9G band –lower 45 MHz to unlicensed*
  - *Upper 20 MHz to C -V2X*
  - *Mid 10 MHz to DSRC or C -V2X (TBD)*
  - *C-V2X experimental license requests and process still unproven*
- Qualcomm marketing is unrelenting, untested and overstated @ scale
- C-V2X (coming to market) and 5G solutions (no where soon) –
  - *MIVSS and CAMP testing of DSRC has nearly 2 decade start*
  - *Going to be a while before other solutions have any solid tests to*
  - *Nobody has implemented or tested SCMS on "new devices"*
- OEMs are mixed on what path they are taking and timing
- Mobility and Ride-Hail Services/Automation are totally disruptive
- Only thing ready and tested to work to improve Safety is DSRC
  - *Those devices and applications need continued work for new locales*
- USDOT has stated safety benefit seen at 30% Fleet penetration
  - *At OEM build state and sales volume annually –will take a while to get there…*

State of Market - current US Vehicle Industry Summary

Manufacturer (OEM)	Commitment ("public")
GM	**DSRC** – Cadillac CTS 2017 on, XTS 2020 on. *C-V2X* - trials
TOYOTA LEXUS	**DSRC** – 2021 multiple models. *C-V2X* – trials
Volkswagen	**DSRC** – 2020 Golf Mk8 (?)

Manufacturer (OEM)	Commitment ("public")
VOLVO	**DSRC** – Volvo Truck trial (current) **DSRC** – Volvo 2018 multiple models
Ford	*C-V2X* - trials
DAIMLER BMW Audi	*C-V2X – trial* commitments

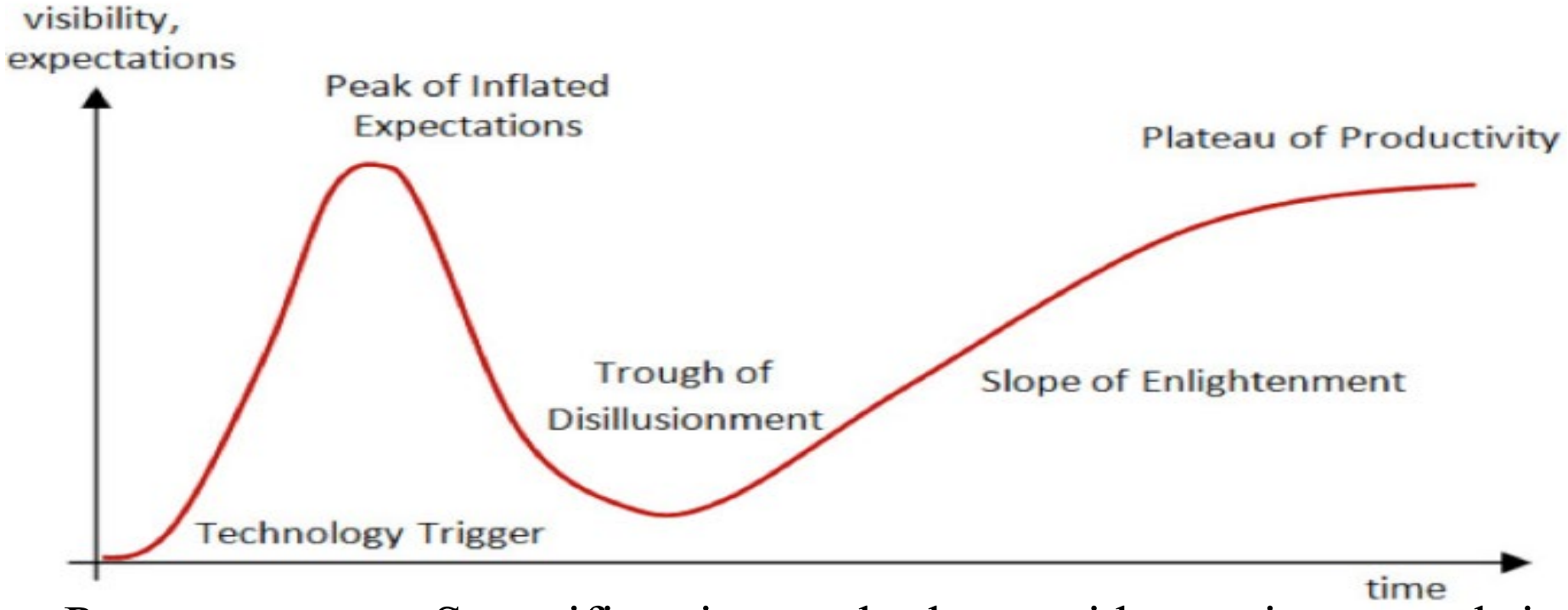
NOTE: Fiat/Chrysler, Honda, Hyundai, Nissan – DSRC testing, no public commitments or production timing/quantities.

Proposed Project Area & Deployment Sites to Evaluate

Risk Comparison by PTC Priority Application - Summary

CV Application/ Function	DSRC (only)	C-V2X (only)	DSRC-C-V2X hybrid	5G (future)
BSM (tx, rx, EEBL, FCW, Collision Avoidance)	Low	Low	Low - Moderate	Very High
TIM-CSW	Low	Low	Low - Moderate	Very High
TIM-RSA	Low	Low -Moderate	Moderate	Very High
TIM-WEA	Low	Low -Moderate	Moderate - High	Very High
TIM-WZ	Low -Moderate	Moderate	High	Very High
TIM-INC	Low -Moderate	Moderate	High	Very High

Suppliers & data providers are not all equal



- Procurement Specifications – help avoid getting stuck in your own trough…
- Prior to deployment/implementation – message and device interoperability testing will be required
- Likely custom tool development will be needed (COTS single-end tool/function not in this space yet)

HCCS - Device & Quantity Recommendations

Timeline	RSU DSRC (only)	OBU DSRC (only) w/ HMI	RSU DSRC/ C-V2X hybrid	OBU C-V2X (only) w/ HMI
P1- Procurement & testing (2020, Q2 -Q4)	5	10	5	10
P1- Deployment (2021, Q1)	5	5-10	TBD (early FCC choice)	TBD (early FCC choice)
State of Market/ FCC NPRM (2021, Q2)	-	-	-	-
P1- Field Acceptance Test/ Re-Evaluation (2021, Q2)	5	5-10	TBD	TBD
P2 - Procurement & testing (2021, Q4)	0-15	0-25	Based on initial trial (15)	Based on initial trial (20)
P2 - Deployment (2022, Q1)	0-15	0-25	0-15	0-20
Test Window (2022, Q1 -Q4)	5	5-10	0-15	0-20

Key Risk Elements for HCC

- Proof of function production certificates for security
  - *Message type by Provider Service Identifier (PSID)*
  - *Hardware Security Module (HSM) per device function w/ SCMS*
- State of the Market – change state and rate of change
- OEM choices vs. FCC or NHTSA rulemaking
  - *Impact volume and schedule of devices*
- New technology devices are largely unproven/tested
  - *C-V2X may become the direction – or not*
  - *No large pilots planned or funded to prove*
  - *Regardless as -is devices have not been tested/certified or conformant*
- Direct procurement leaves requirements/function out for PTC

Key Risk Elements for HCC

- Capital + O&M costs of edge compute vs. functional use, benefits and compute power at-scale/RF availability
  - *Standards changes upcoming and change support through products/services dramatically affect edge compute solutions*
  - *IT suppliers generally don't have good transportation solutions*
- Device testing/message (payload) conformance
- RSU and OBU device procurement
  - *OmniAir certification is minimum requirement*
  - *Implementation and functional interoperability with SCMS and required HSM per device, certifications per message set*
- Cost of development/automation for message broadcast
  - *ATMS, Kinetic and various other system interfaces/hand -offs*
  - *Messages must -be signed by device sending message and broadcasting the message in CV space*

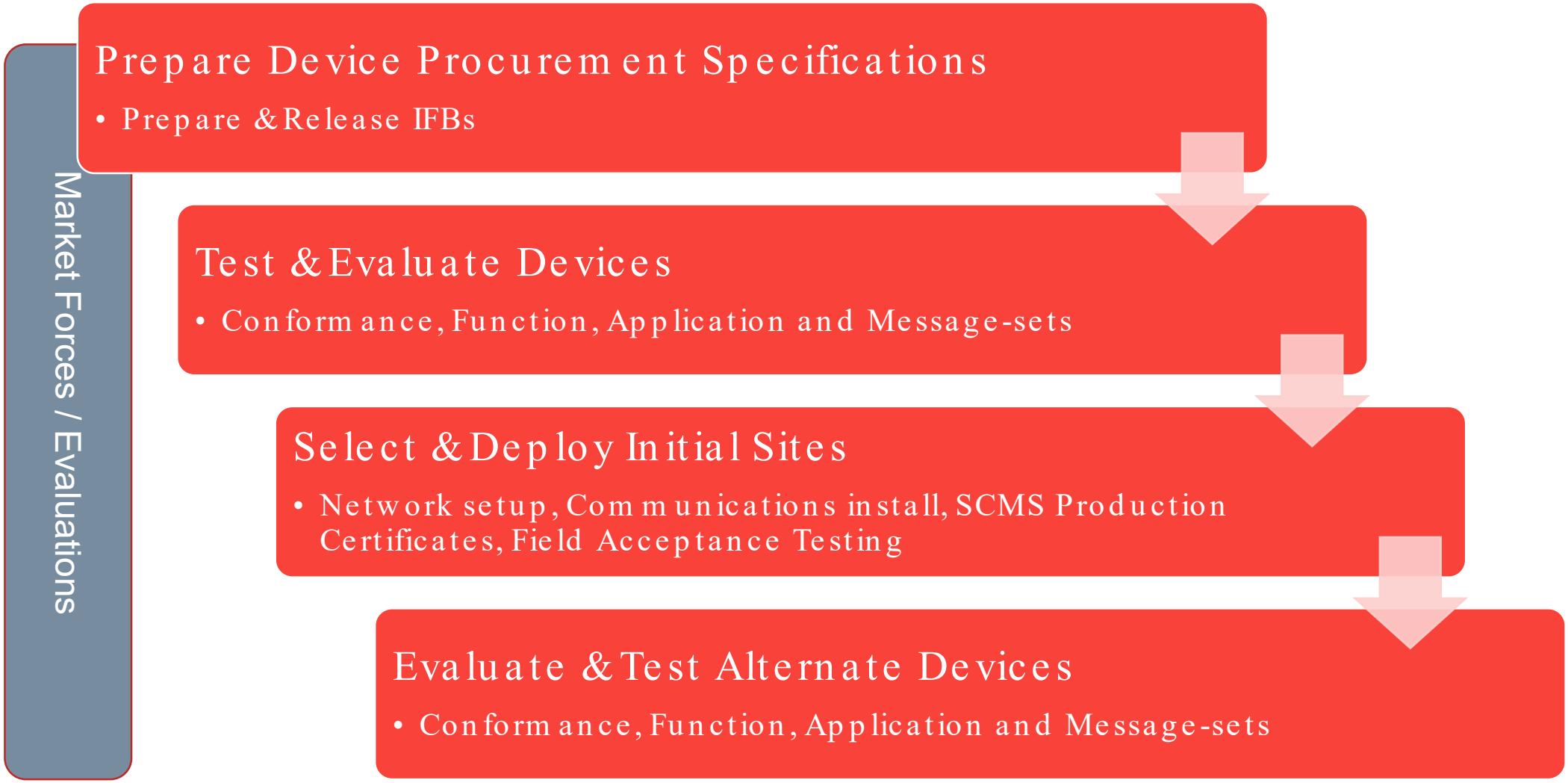
Recommendations Summary - 01

- Install separate ISP link – firewall, router for CAV "traffic"
- Setup National Architecture conformant production SCMS "services" for HCCS devices by PSID
- Develop and release procurement specifications
  - *HCCS CAV devices*
  - *Lab Test CAV devices*
- Implement testing regimes for CAV devices and production certificates as part of selection
- Develop testing and implementation criteria for Lab CAV devices/applications prior to field implementation

Recommendations Summary - 02

- Implement best practice and recommendations for security from the HCCS Security Management and Data Management Plans
- Change CAV device logins to support security best practices prior to bench & field installations
- Setup IP4 and IP6 addressing and routing for separating CAV devices on PTC network
  - *Test and validate SCMS function with procured devices*
- Procure devices to mitigate risk vs. sunk costs
  - *(5) DSRC RSUs and (10) DSRC OBUs –HCCS early deployment*
  - *(5) Hybrid RSUs and (10) C -V2X OBUs –HCCS lab, testing and evaluation*
- Complete setup and installation of remaining "detailed" ConOp recommendations

HCCS – How to walk deployment forward…



Next Steps / Q&A

- Finalize Concept of Operation document
- Setup task for Procurement Specifications (RSUs & OBUs)
  - *Finalize DSRC equipment and quantities*
  - *Prepare C -V2X requirements, equipment, quantities*
- Determine what/how to procure a SCMS provider/service
- Setup task for support for Site Selection/Evaluation
  - *Continue Fiber build -out, Communication Installation, Back - office, Routing definitions*
  - *SCMS procurement and network changes to support*
- Continue to monitor and evaluate changes in Market/Standards