

# FIGHTER SYSTEM SIMULATION

Using SLSC to perform signal conditioning – a transition

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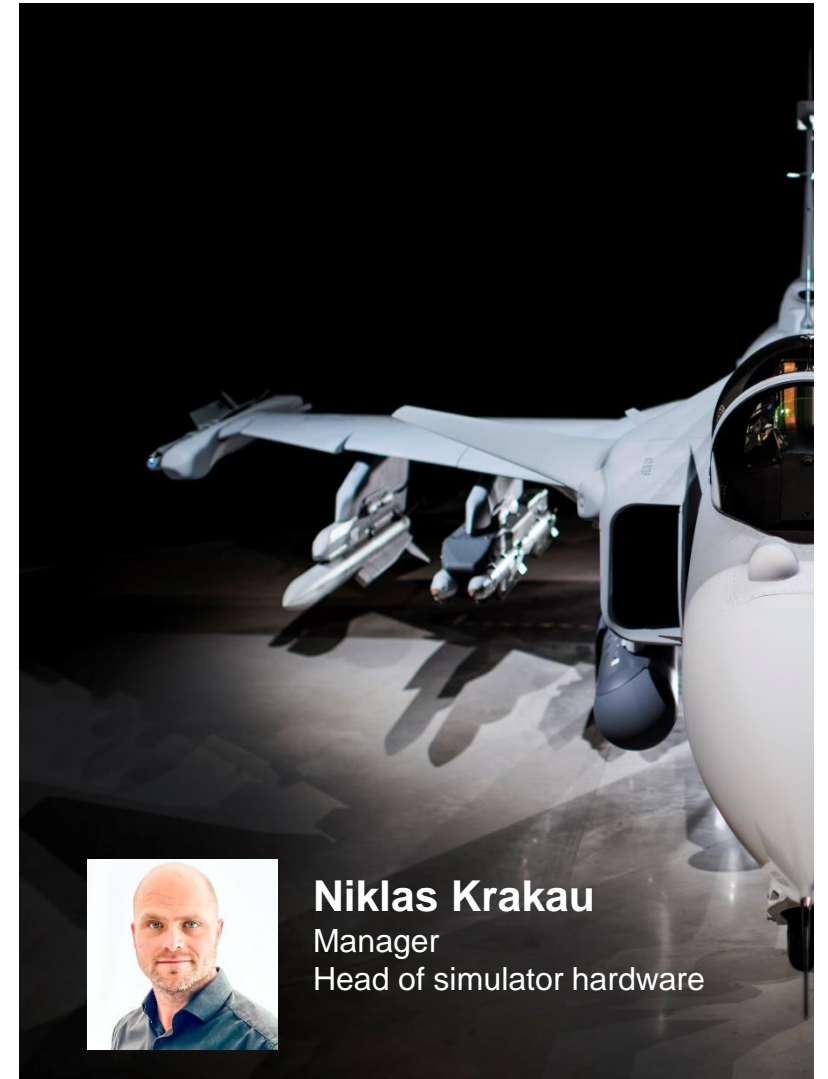
# AGENDA

- **Presentation and scope**
- **HIL, overview**
- **The transition to COTS hardware**
  - Why, how and when
- **Current benefits & challenges**
- **Next steps**
- **Questions**



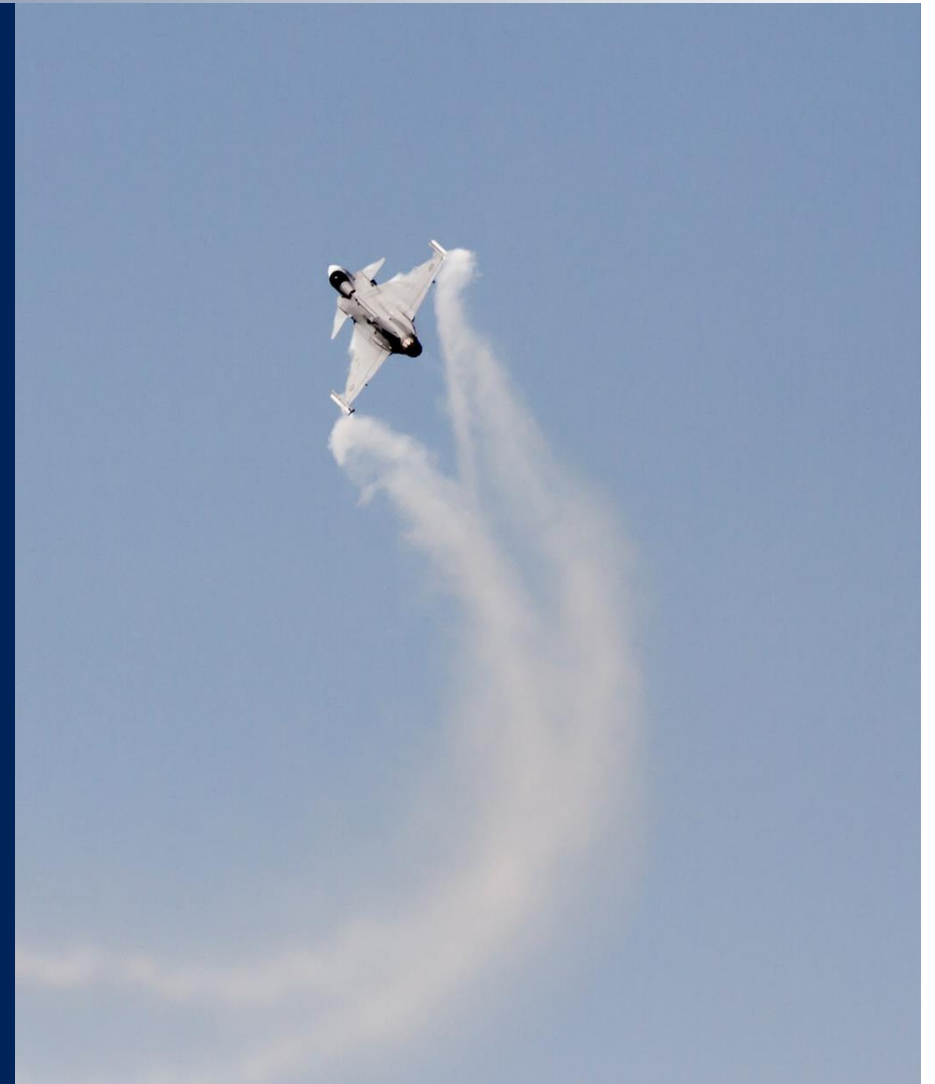
# SIMULATOR HARDWARE AND PRODUCTION

- **40 engineers within different projects, including**
  - Development simulators
  - Training simulators
- **Broad responsibility**
  - Board design, system design, maintenance and calibration
- **Located** in Linköping, Sweden
- **Product focus** Gripen C/D/E
- Part of the department **"Simulators, training and support"**
  - Approximately 270 employees
  - Modelling, firmware, integration, operation, maintenance and more



# AGENDA

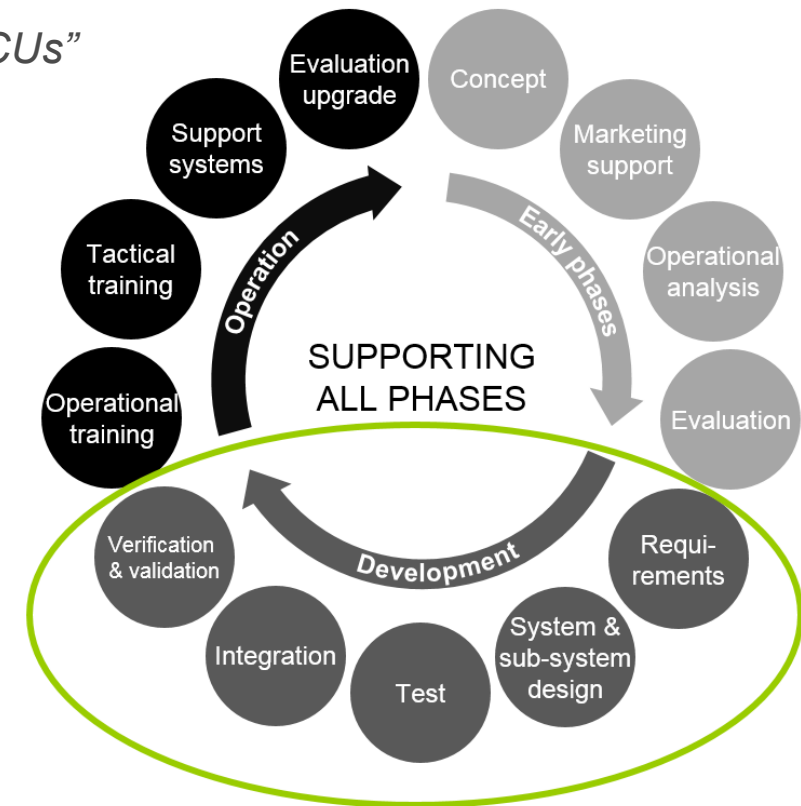
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# HIL SIMULATOR HARDWARE OVERVIEW

- **Simply put:**
  - *"Provide a realistic electrical environment for the avionics and other ECUs"*
  - *Connect ECUs and perform realistic system testing*
- **We use HIL simulation to:**
  - Test system software
  - Test integration
- **Assumptions:**
  - The ECUs are fully functional and have been tested in advance
- System testing, **not** hardware testing...



# ANATOMY OF A **HIL** ADAPTOR UNIT

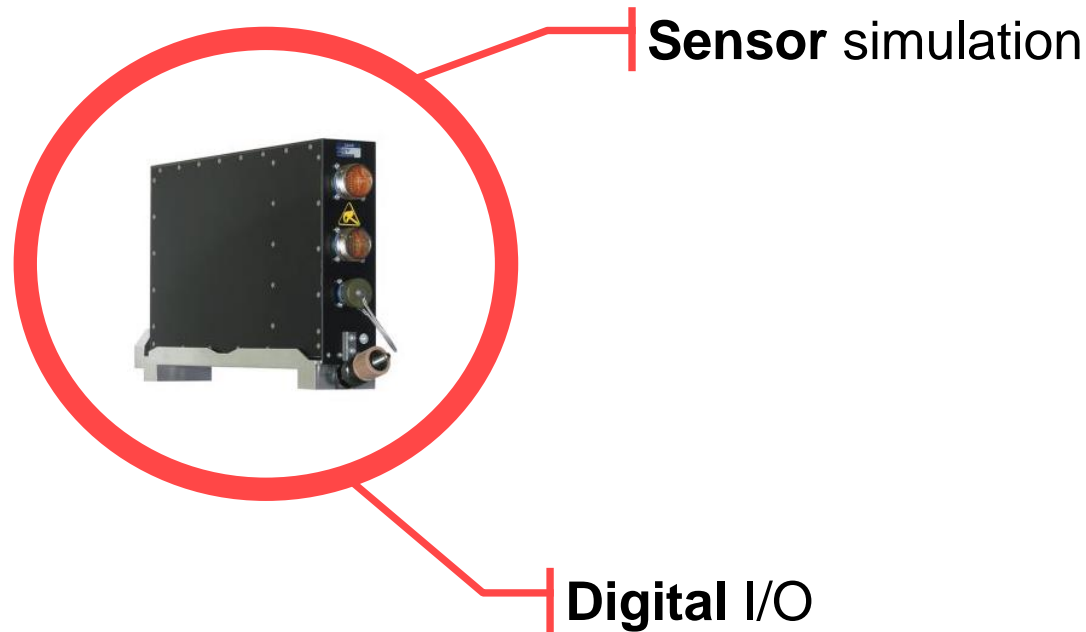
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## **Adaptor Unit (AU)**

- A "shell" around the ECU
- "Interface simulator"

# ANATOMY OF A **HIL** ADAPTOR UNIT



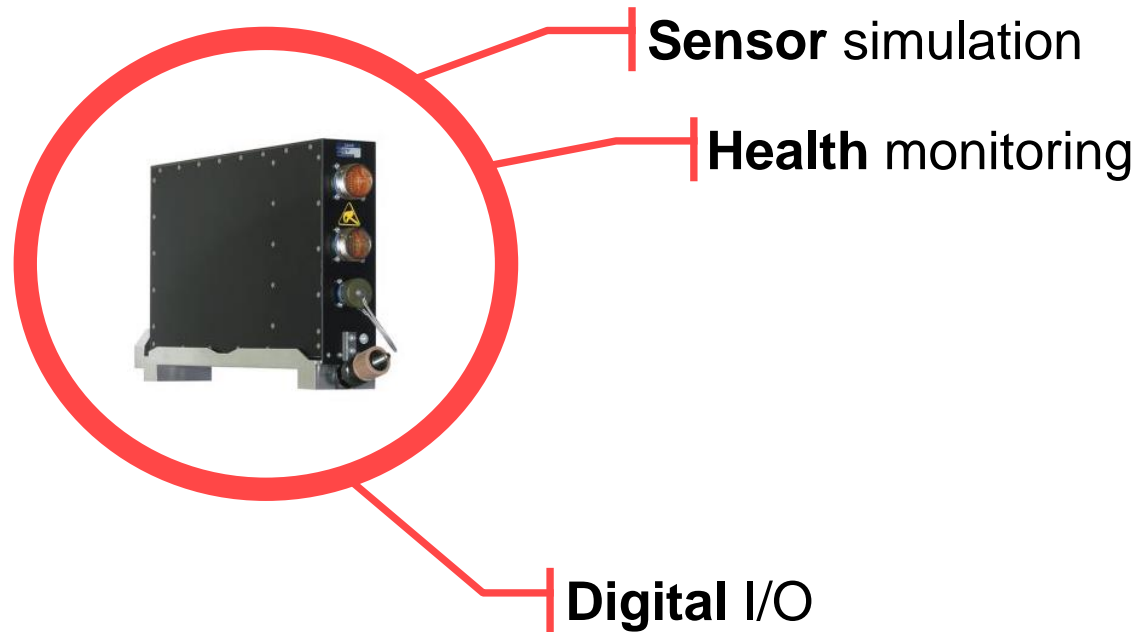
## **Sensor simulation**

- Stimulate sensor inputs of ECUs
- Precision requirements
- Need to cope with function monitoring

## **Digital I/O**

- Stimulate digital inputs such as buttons, levers, switches
- Relay functions
- Isolated (opto)

# ANATOMY OF A **HIL** ADAPTOR UNIT

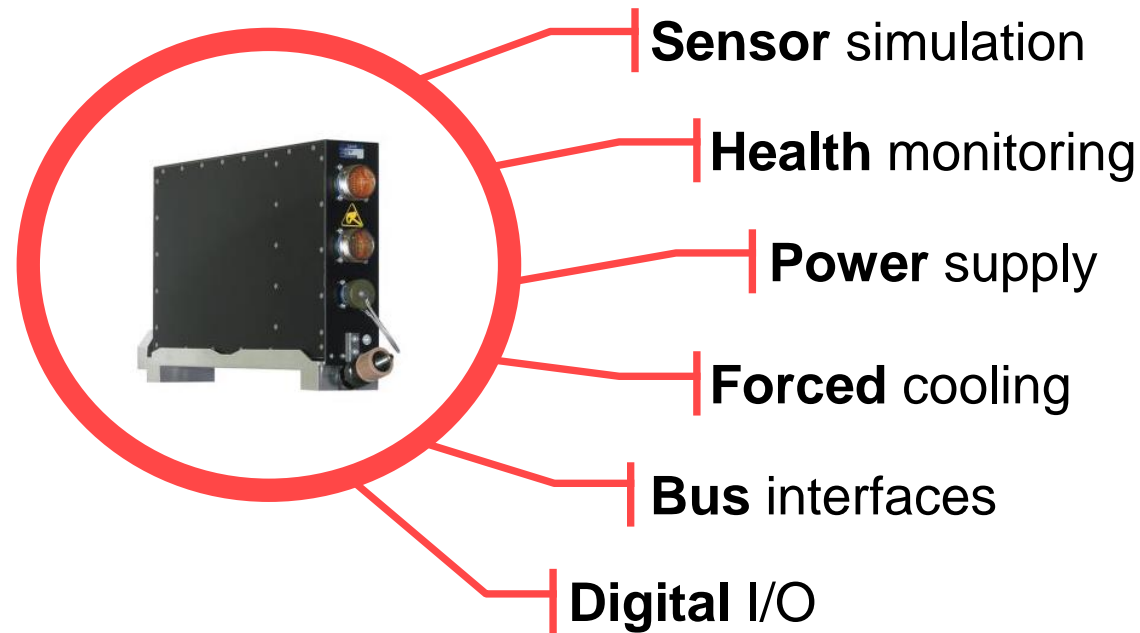


## **Health monitoring (PEMU)**

- Monitor cooling
- Monitor power
- Switch power on/off
- Essential to maintain air worthiness



# ANATOMY OF A **HIL** ADAPTOR UNIT



## **Power supply**

- Depending on ECU

## **Forced cooling**

- Depending on ECU

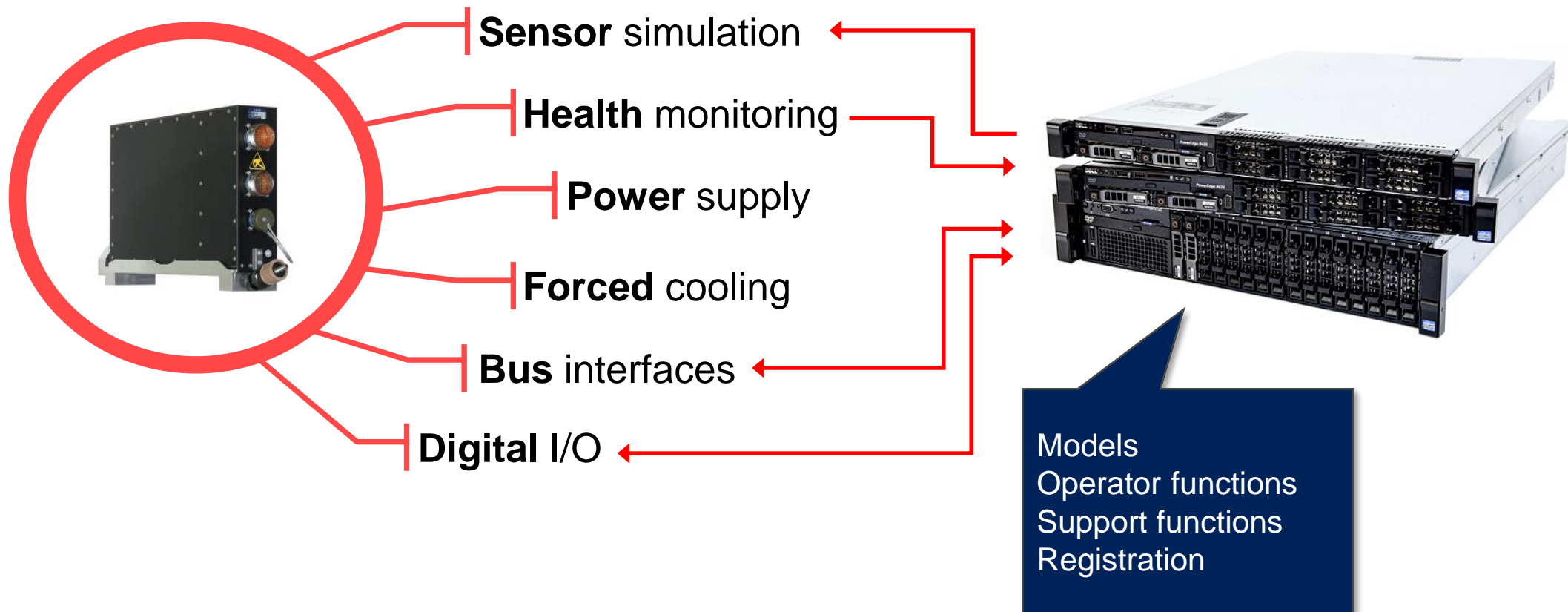
## **Bus interfaces**

- Not via I/O

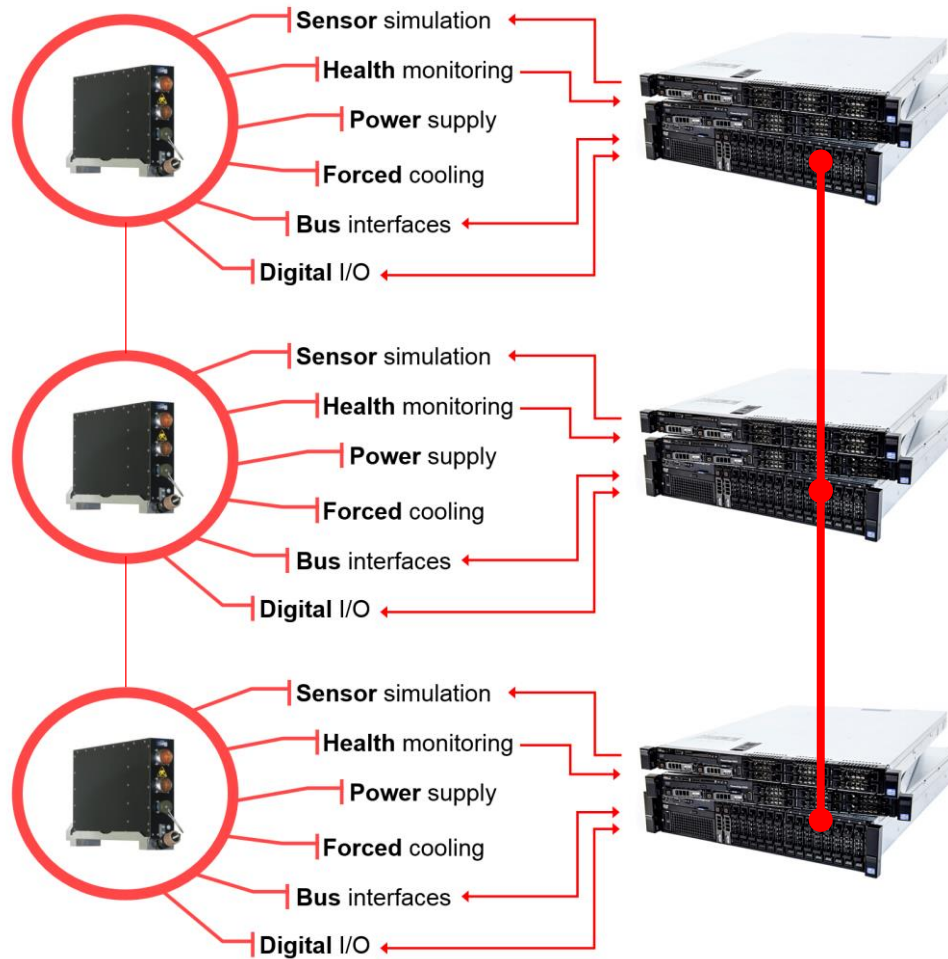
## **Test equipment**

- Break out boxes
- Terminals
- Debug equipment

# ANATOMY OF A **HIL** SIMULATOR



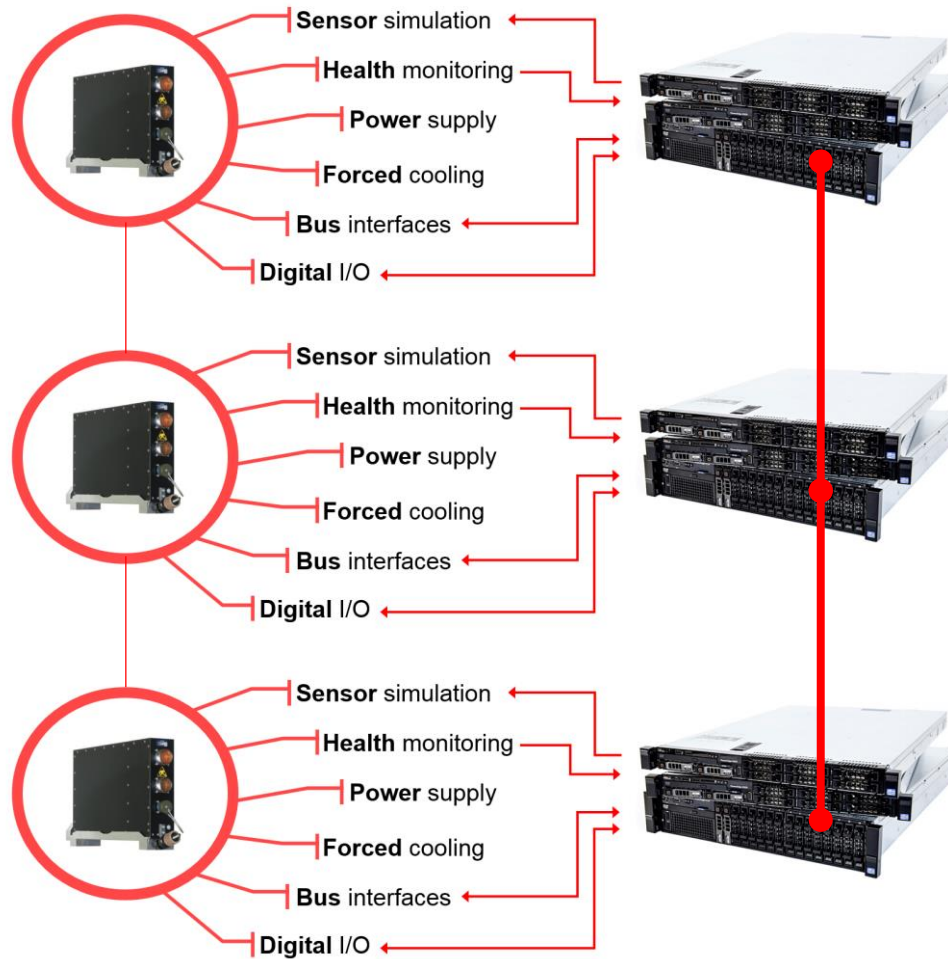
# ANATOMY OF A HIL SIMULATOR



## More ECUs

- Networked
- Direct connections
- Synchronization

# ANATOMY OF A HIL SIMULATOR



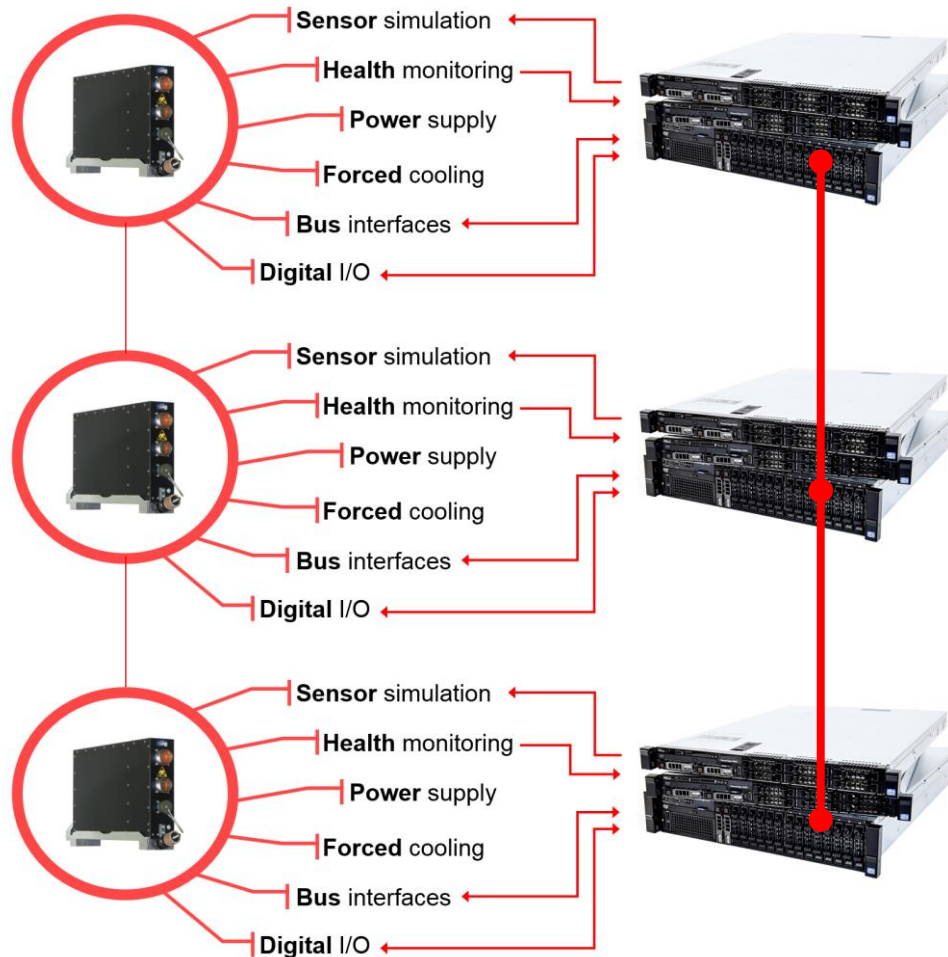
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## Pilot station

- Cockpit incl controls
- Out the window visualization

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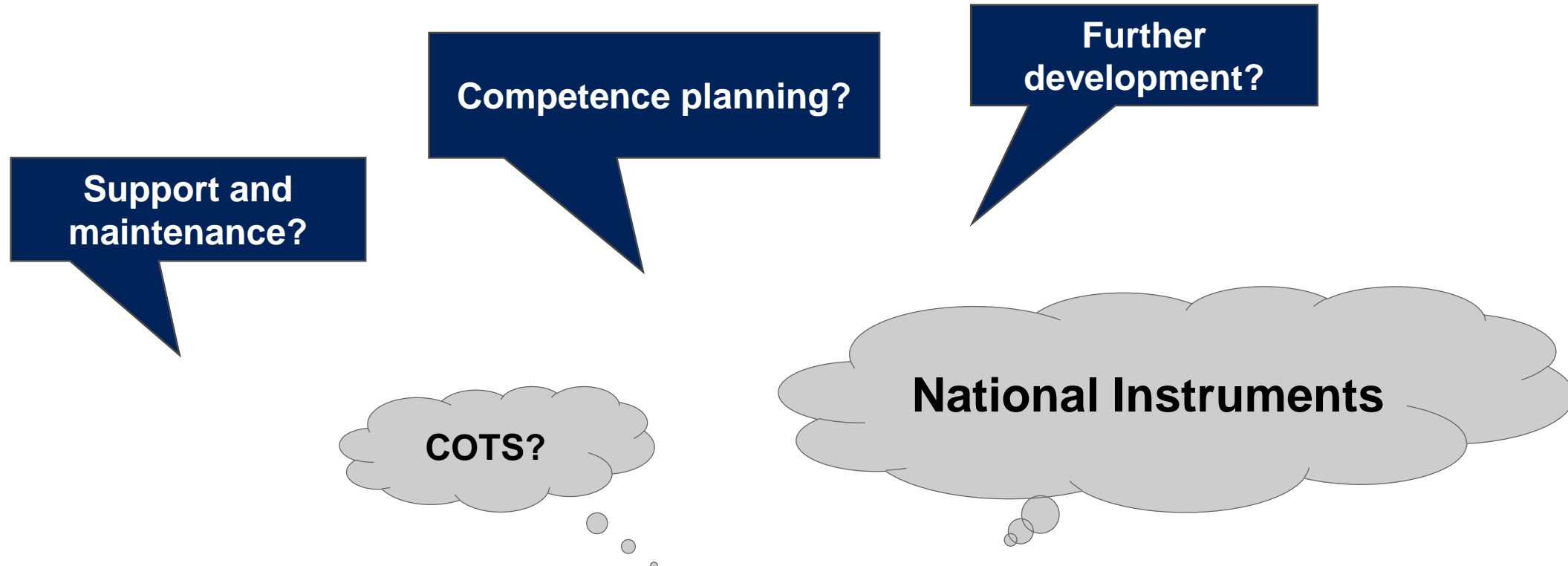
## Operator station

- Supervision
- Registration
- Test management

# WHAT IF?

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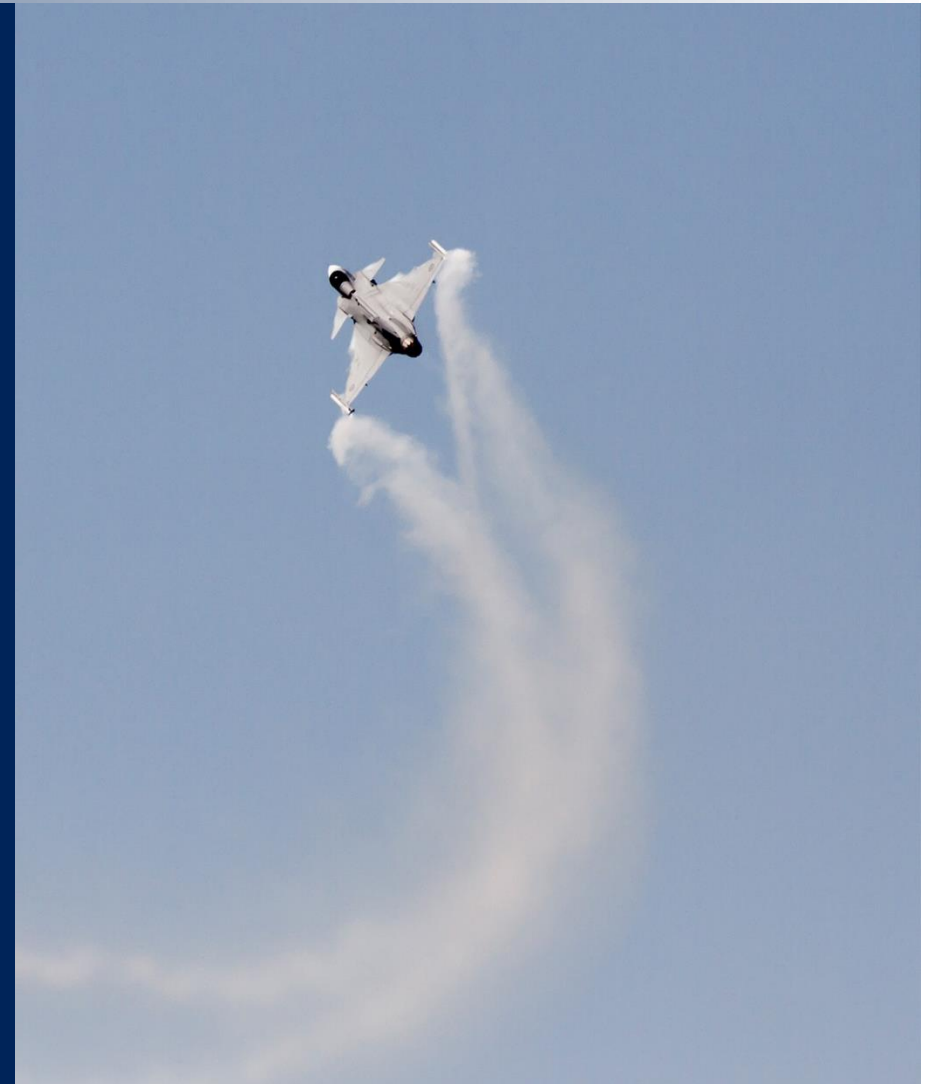
**"What if we were to build HIL facilities off-site?"**





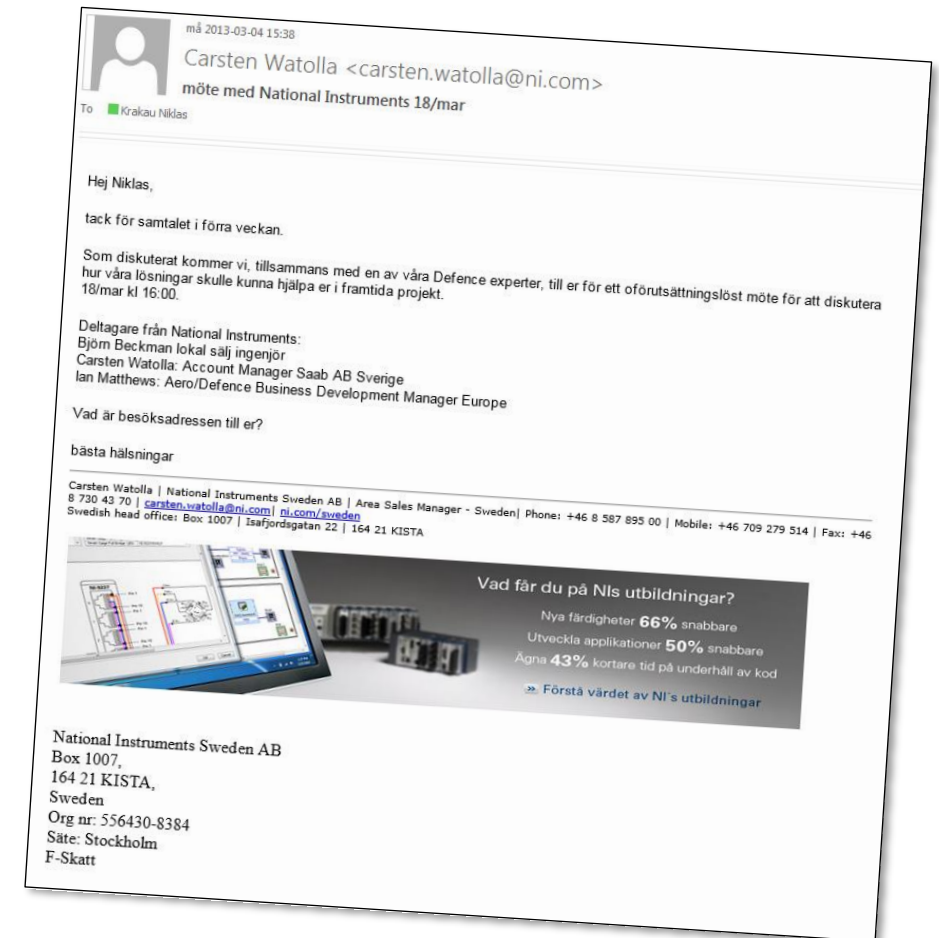
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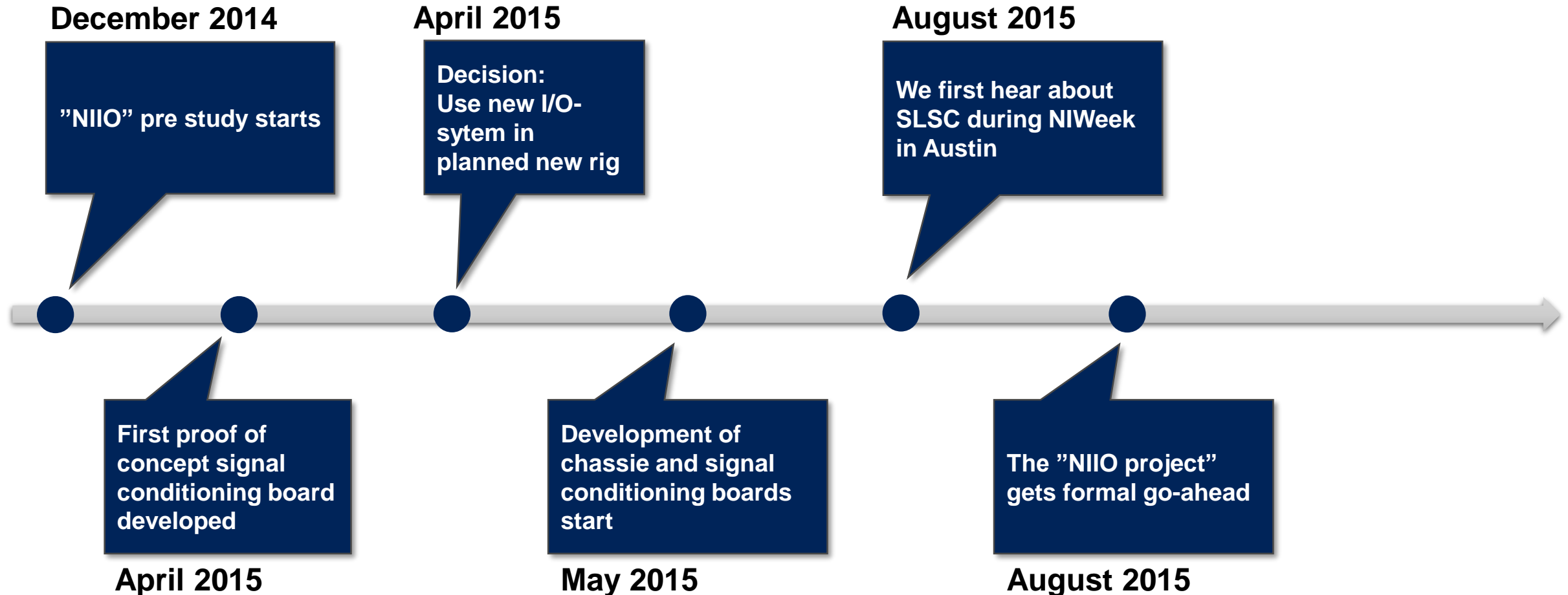


# PRE-HISTORIC TIME (2013-2014)...

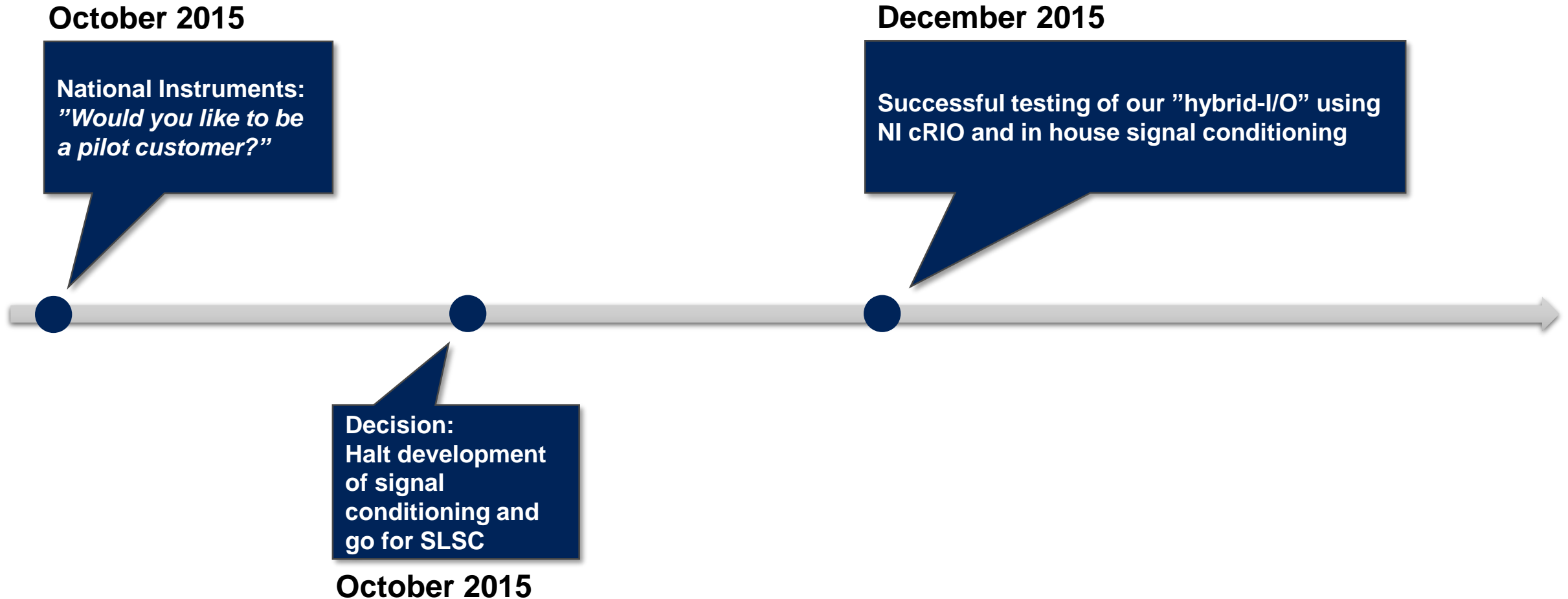
- **March 2013**
  - National Instruments visited us
- **Pre-study from National Instruments**
  - We needed to make sure deterministic timing was possible
- **Decision to go ahead!**
  - New hardware
  - Emulate legacy system to minimize workload/lead time
  - COTS I/O, in-house signal conditioning



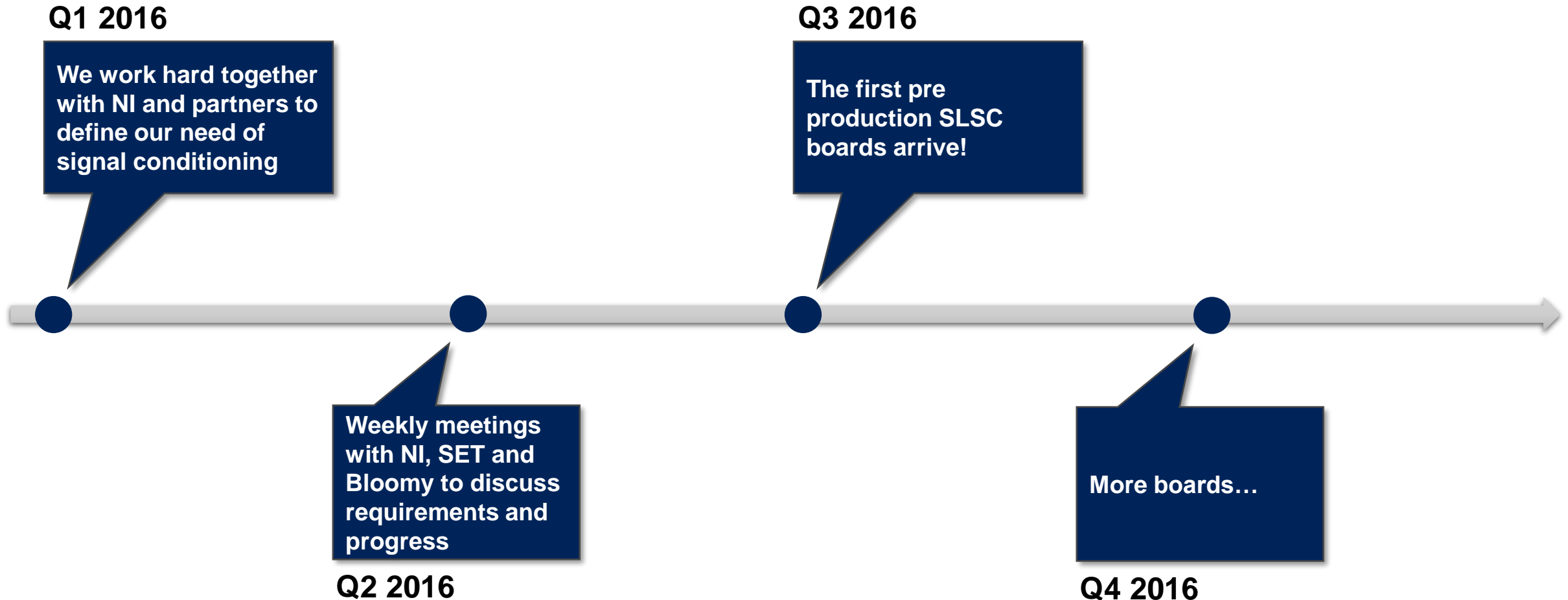
# TIME LINE 2014-2015



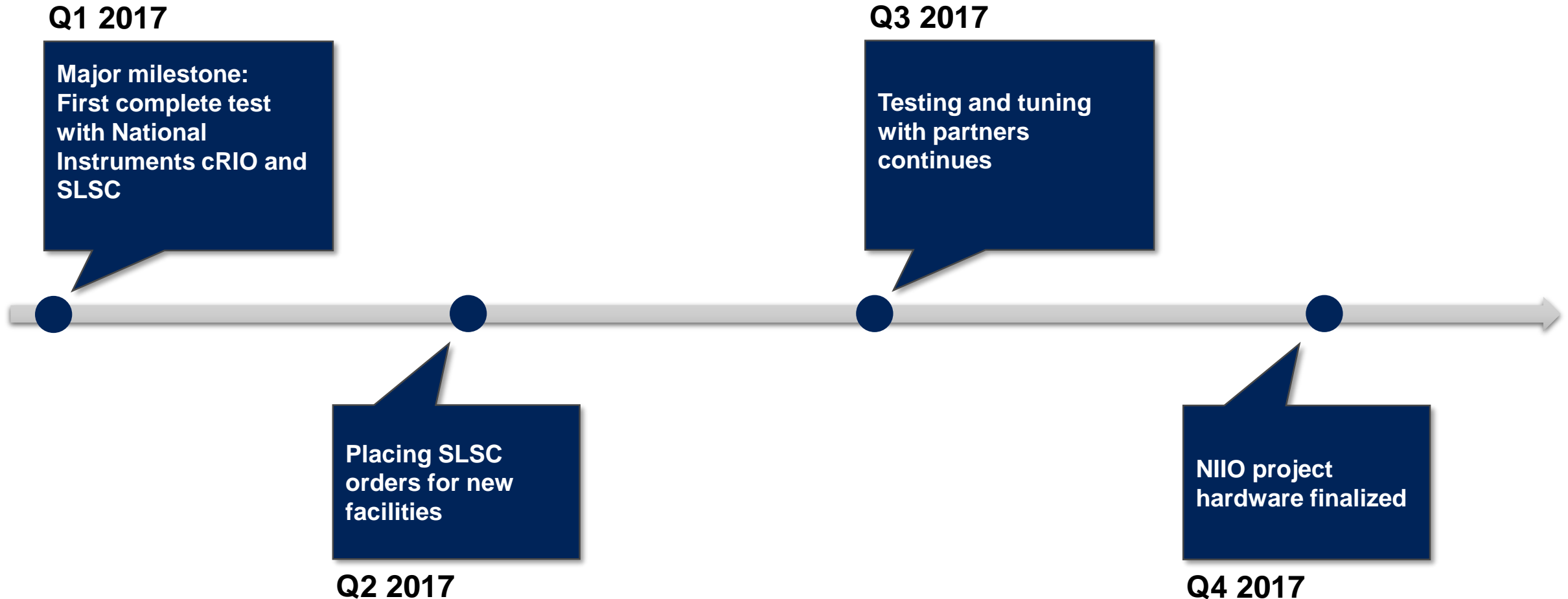
# 2015: ENTER SLSC



# 2016: THE YEAR OF SLSC DEVELOPMENT



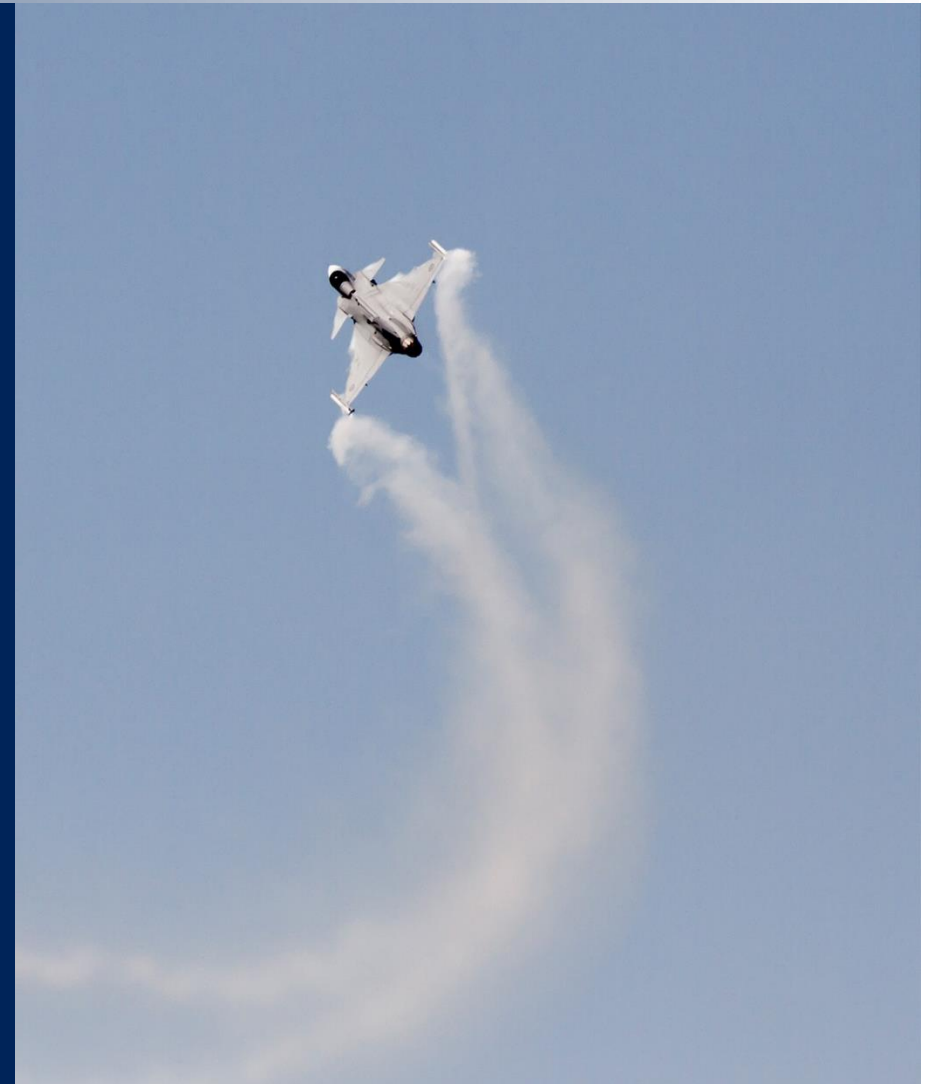
# 2017: IT'S COMING TOGETHER





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# COMPACT RIO AND PXI

- Mainly **CompactRIO**
  - Cost effective and robust
- **PXI** only where necessary due to timing or performance requirements
- **CompactRIO** is sufficient since models run on simulation computers



# SLSC MODULES

- Digital I/O
- Opto-isolated I/O
- Relay/Feedthrough I/O (Saab specific)
- Resistance simulator
- R/LVDT+Resolver simulator
- R/LVDT Demodulator (Saab specific?)
- Capacitance simulator (Saab specific)



# HIL SYSTEM, PEMU

## • PEMU

- Power and Environmental Monitoring Unit
- Monitors cooling air (temp, pressure)
- Monitors power (voltage, current)
- Power on/off to ECU
- Developed in-house
- cRio control from simulation and operators station



# HIL SYSTEM, SYNCHRONIZATION

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- Synchronization is **vital**
  - ECUs, computers and I/O need to be precisely synchronized
  - Several possible sync sources
- Our **solution**
  - **PXI**, due to better timing precision (latency, GPS HW)
  - In-house developed pulse transmitter equipment
  - Uses industry standard M-LVDS



# THE TRANSITION, SIMPLIFIED



## Transition to commercial off the shelf (COTS)



**Note:** We still have to design ECU monitoring and some custom SLSC boards



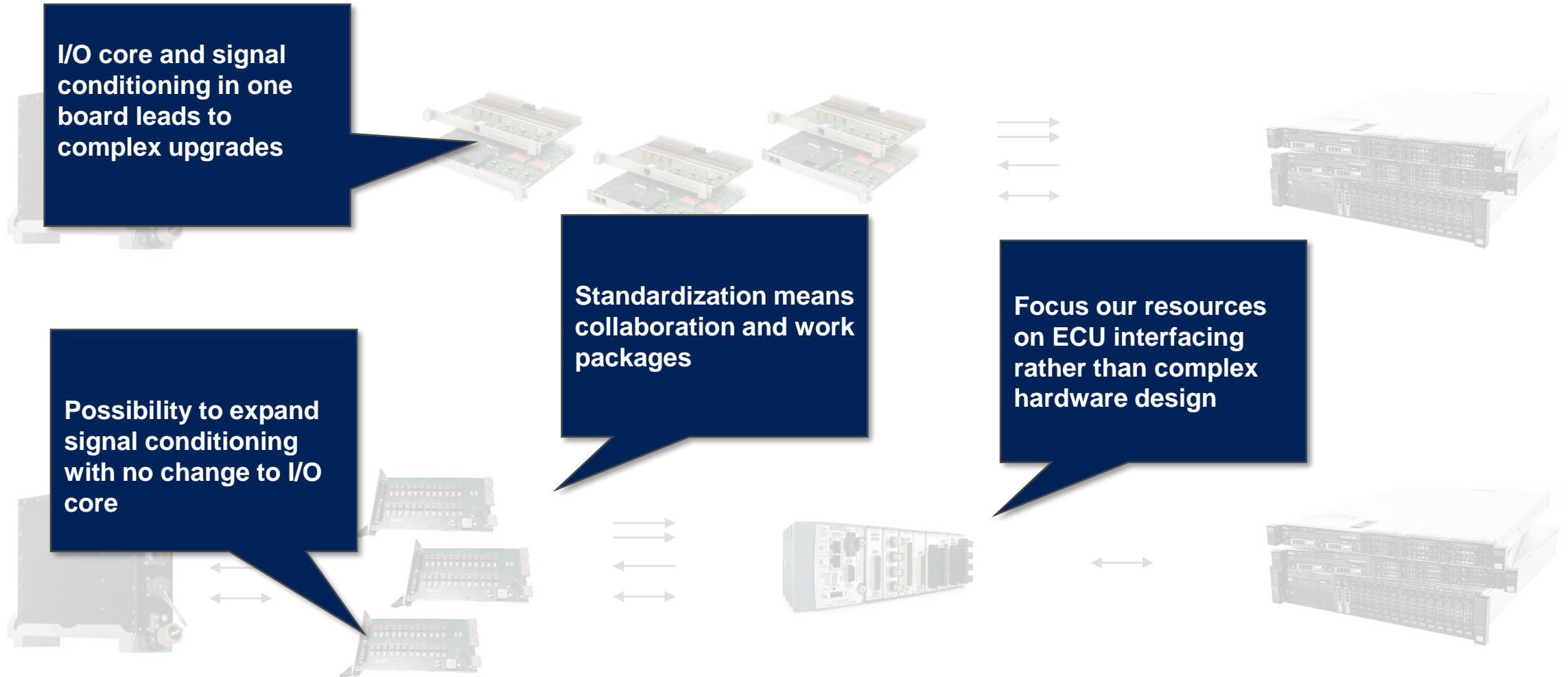
# THE TRANSITION, BENEFITS

I/O core and signal conditioning in one board leads to complex upgrades

Possibility to expand signal conditioning with no change to I/O core

Standardization means collaboration and work packages

Focus our resources on ECU interfacing rather than complex hardware design



# KEY SUCCESS FACTORS

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- Work with **experienced** partners
  - National Instruments, SET, Bloomy...
- **Commitment!**



The Leader in Automated Test, Data Acquisition, and Control Systems



# KEY SUCCESS FACTORS

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- **Introduce** new technology stepwise
  - Keep risk as low as possible
- **Involve** current domain experts
  - Acknowledge skill and expertise
- **Provide** workshops and courses
  - "Google Friday"-setting?

# DID WE ACHIEVE OUR GOALS?

## Competence

Avoid single point competence

Competence development



Easier to maintain knowledge

Possible to find already experienced engineers

## Support

Support multiple facilities  
Off-site support  
Obsolescence



Possible to out source maintenance

Obsolescence management "included"

## Standardization



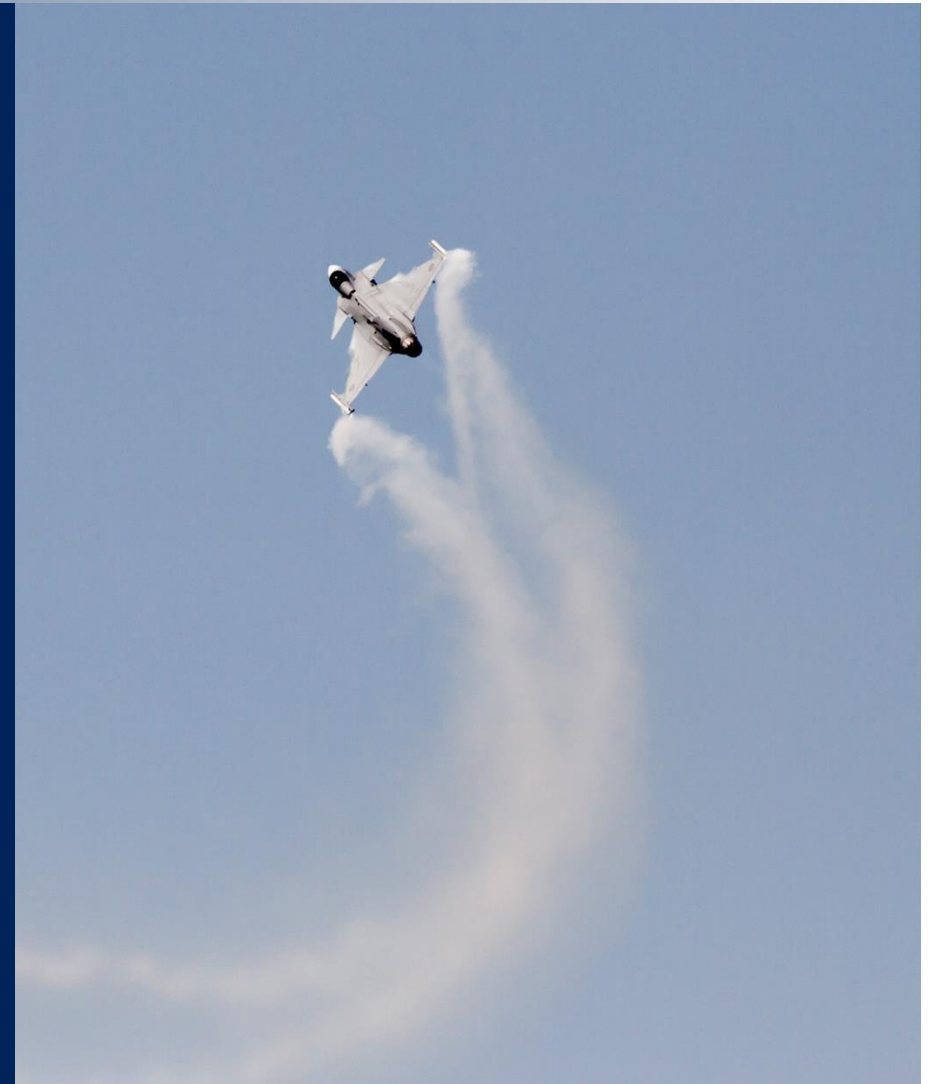
Custom boards benefit from standardized interface

Collaboration

More COTS boards are needed!

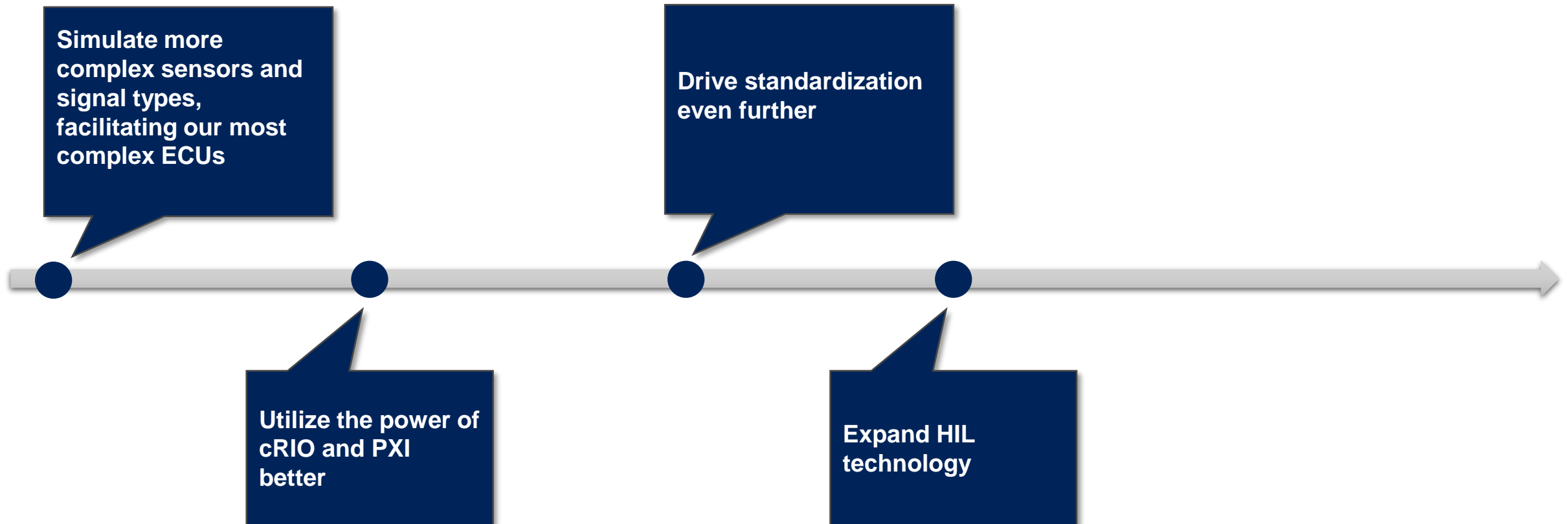
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# 2018 AND FORWARD

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# THANK YOU!

QUESTIONS?



## BLIV kilo-GRAM-JÄGARE

Vill du att flygplanet du bygger skall bli i toppklass?  
När du bygger på din egen önskan.  
Kom då ihåg att du vill att flygplanet ej skall bli tungt och svårt.  
Du skall också veta att du vill att man be-  
tycker på att du vill att flygplanet skall bli lätt och snabbt.  
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BLIV DÄRFÖR  
kilo-GRAM-JÄGARE