RoSES: Robust Self-configuring Embedded Systems
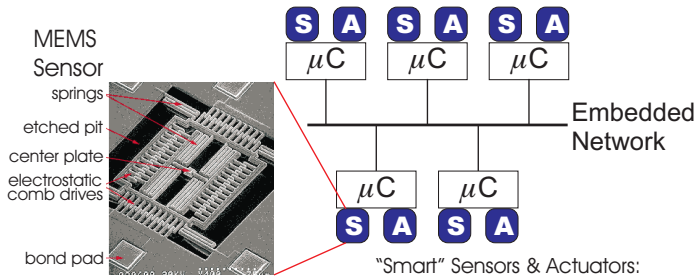
RoSES

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Research Question:

Can we achieve automatic graceful degradation?

MEMS Sensor
- springs
- etched pit
- center plate
- electrostatic comb drives
- bond pad

S A S A S A
μC   μC   μC

μC   μC
S A S A

Embedded Network
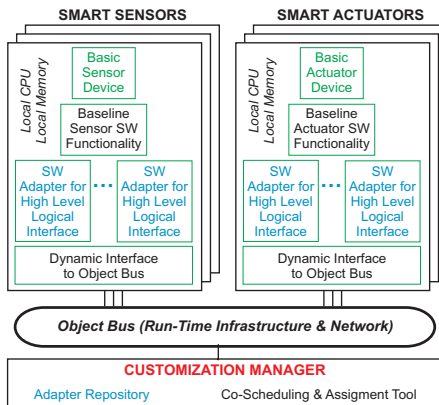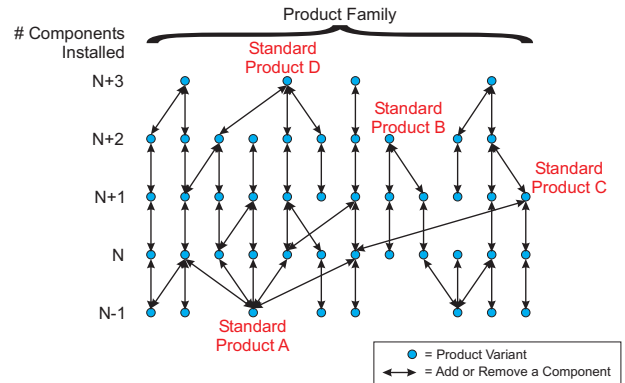
"Smart" Sensors & Actuators:

Context:

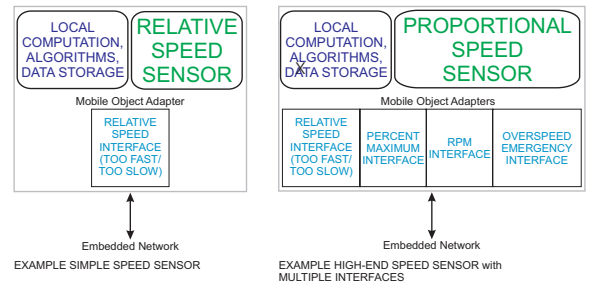**Very fine grain distributed real-time embedded systems**

Conceptual Approach:

Product Family Architectures
- ► Point in product family lattice determined by installed components
- ► Installing/removing a component transforms system to another product family cousin
- ► *Unified framework* for: - graceful degrades
  - field upgrades
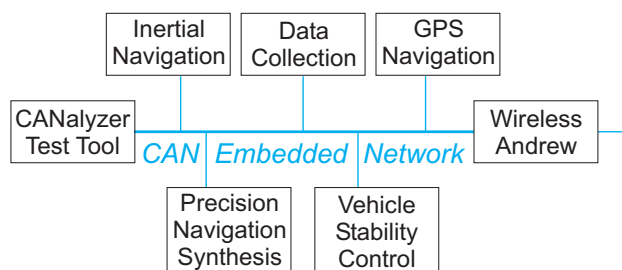 - emergency non-exact spares
  - logistical flexibility

Product Family

Components Installed

Standard Product D
Standard Product B
Standard Product C
Standard Product A

N+3
N+2
N+1
N
N-1

● = Product Variant
◄──► = Add or Remove a Component

SMART SENSORS

Local CPU Local Memory

Basic Sensor Device

Baseline Sensor SW Functionality

SW Adapter for High Level Logical Interface • • • SW Adapter for High Level Logical Interface

Dynamic Interface to Object Bus

SMART ACTUATORS

Local CPU Local Memory

Basic Actuator Device

Baseline Actuator SW Functionality

SW Adapter for High Level Logical Interface • • • SW Adapter for High Level Logical Interface

Dynamic Interface to Object Bus

Object Bus (Run-Time Infrastructure & Network)

CUSTOMIZATION MANAGER

Adapter Repository   Co-Scheduling & Assigment Tool

Key Technical Pieces:

- ► Mobile object adapters for reconfiguration support
- ► Configuration Manager
- ► Run Time Infrastructure
- ► Architectural Selection

LOCAL COMPUTATION, ALGORITHMS, DATA STORAGE

RELATIVE SPEED SENSOR

Mobile Object Adapter

RELATIVE SPEED INTERFACE (TOO FAST/ TOO SLOW)

Embedded Network

EXAMPLE SIMPLE SPEED SENSOR

LOCAL COMPUTATION, ALGORITHMS, DATA STORAGE

PROPORTIONAL SPEED SENSOR

Mobile Object Adapters

RELATIVE SPEED INTERFACE (TOO FAST/ TOO SLOW) | PERCENT MAXIMUM INTERFACE | RPM INTERFACE | OVERSPEED EMERGENCY INTERFACE

Embedded Network

EXAMPLE HIGH-END SPEED SENSOR with MULTIPLE INTERFACES

Experimental Testbed

- ► Application: Navigation, then Active Vehicle Stability Control
- ► Simulation testbed
- ► Lab hardware testbed
- ► CAN-based vehicle

Inertial Navigation | Data Collection | GPS Navigation

CANalyzer Test Tool

CAN Embedded Network

Wireless Andrew

Precision Navigation Synthesis | Vehicle Stability Control

GM

BOSCH

Institute for Complex Engineered Systems

Electrical & Computer ENGINEERING