IOTWeek

Dublin — June 20-23, 2022

# Collaboration between the European Commission and the US NSF:

# Fundamental advancements in programming, coordination, and intelligence across the computing continuum

Marc Duranton

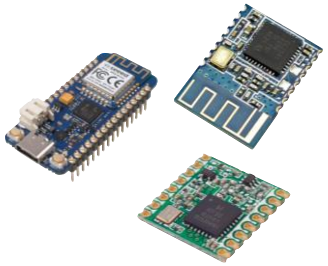
Jason O. Hallstrom

IOTForum

# Observations (1/4)



## IoT applications have become easier to build

Hardware platforms are more capable and reliable, without sacrificing too much energy efficiency or increasing costs

Software enablement platforms, libraries, and supporting tools abound across the stack

There is a large community of developers

**Young kids are building interesting IoT applications**

# Observations (2/4)

## IoT applications have become **harder** to build

They are increasingly heterogeneous

Abstractions for simplifying construction and analysis lag behind

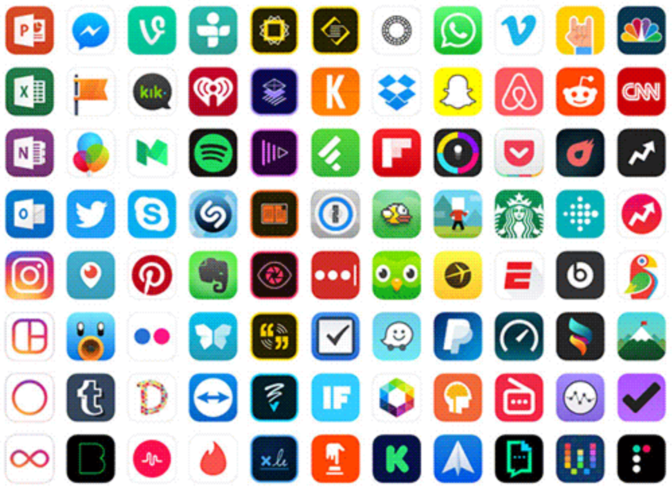
**Experts are struggling to build interesting IoT applications**

# Observations (3/4)

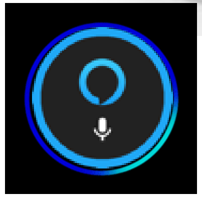


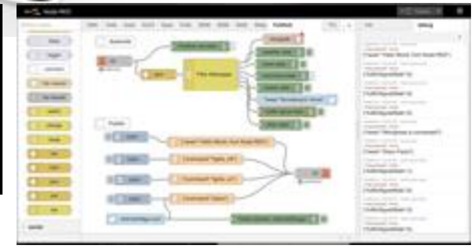
**Overflow of service-specific apps**
(e.g. App from a hotel to *book a room*)
Aggregator apps to select a service (e.g. booking)
Even aggregators of aggregators (e.g. Kayak)
...
Overflow of information, choices, interfaces, etc.

**Industry/users only want "*services*" selected according to their requirements**



**Computing is more intertwined with the world**
More "natural" interfaces: voice, drawing, gestures, ...
Aware of the environment
Adapt input and output to the situation





***"Natural" programming:***
***Connecting "services" via libraries, orchestration languages (e.g., Python), voice, specifications, graphical interfaces – or even by example***

# Observations (4/4)



## In nearly all hardware and software systems:

- **Time is abstracted** or not present at all
  - Very few languages can express time or timing constraints linked to real-world applications
- Average **-not predictable-** performance is the goal
  - Caches, out of order execution, branch prediction, speculative execution
  - (Hidden) compiler optimizations, call to (time) unspecified libraries
- **Energy and virtually all other resources are also left out** of scope
  - This can have impact on data movement, optimizations, etc.
- **Interactions with external world** are second order priorities
  - Done with interrupts (introduced as an ***optimization***, eliminating unproductive waiting time in polling loops), which were designed to be ***exceptional events***
- etc.

# Let’s BE KIND to system developers

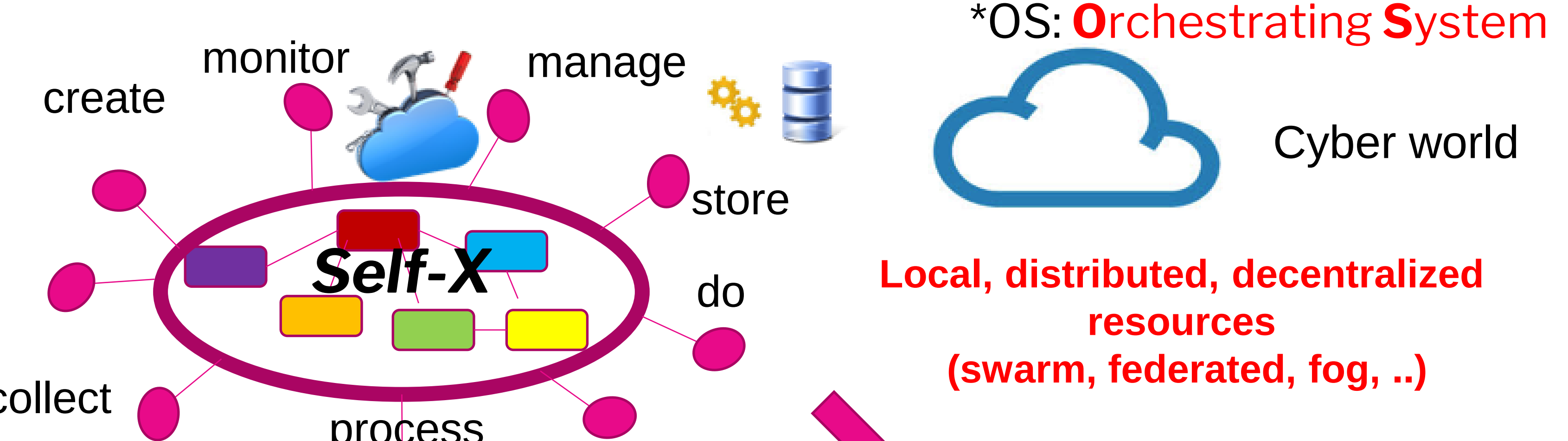
**Unifying abstractions for heterogeneous distributed systems interacting with the world could lead to profound productivity and reliability improvements**

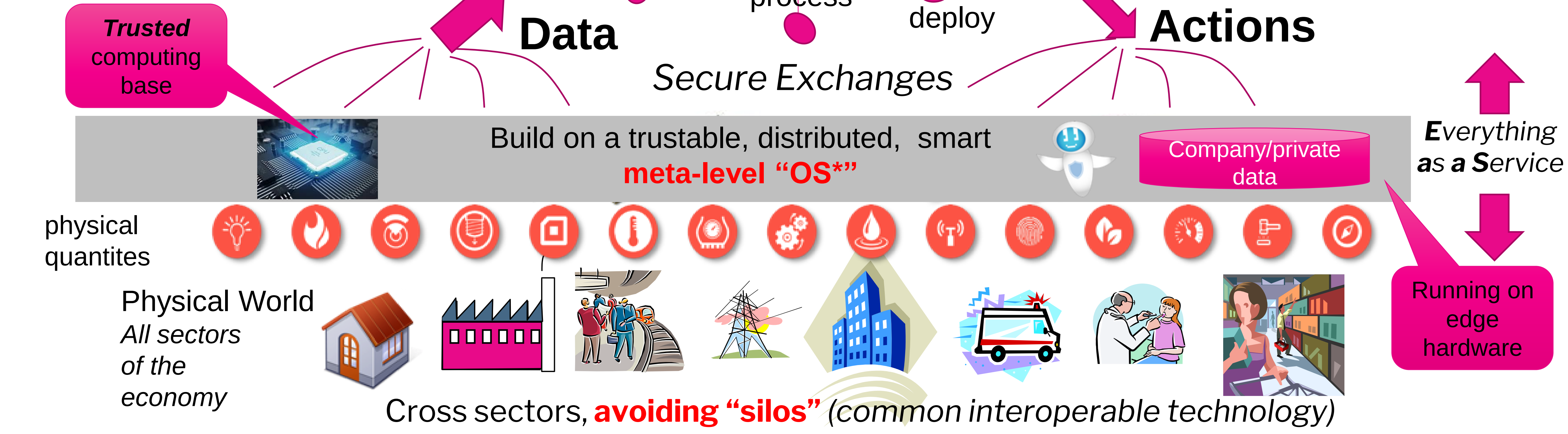
- Documentation —dare I say, *specification*— abstractions
- Algorithmic and data structure abstractions
- Programming language abstractions
- Supporting cross-stack services

# Distributed Intelligence via Sharing and Coordination of Resources Across Heterogeneous, Connected, Locally Managed Devices



- ***Dynamic*** construction of applications from **distributed services** (local or remote)
- Taking into account ***non-functional requirements*** (time, latency, locality, energy, privacy, cost, …)
- Using ***high level abstractions***
- Services (and resources) ***where*** they are the most efficient
- Built on top of existing technologies (e.g. IP, REST, IEEE P2874, …)



# The challenge: Interoperability and Composability (Orchestration)

*Getting the complete picture by putting the pieces together thanks to **high level abstractions***

**Too complex for users:**
**High level abstractions and Smart Orchestrator**

Creating the ***next Web***, ***decentralized***, based on ***shared resources,*** *intertwining* Cyber and Physical worlds (*WEB* + *IoT/actuators*) for ***industrial*** and personal use

*Built on top of existing technologies (IP, REST APIs, etc…)*

**Defragmentation of vertically-oriented, closed systems**
Move towards open platforms, frameworks, and standards

**Heterogeneity/Interoperability**
Handling numerous types of devices, resource constraints, protocols, standards, and related ***non-functional requirements and constraints***

**Scalability**
Handling large numbers of connections, requests, and data flows across heterogeneous networks and devices

**Dynamicity**
Plug&play, self-configuration, self-management, self-matchmaking (… self-X)

**Privacy**
Safeguarding confidential and/or proprietary data of companies, individuals, and stakeholders

**Security**
Protecting computing assets against viruses, hackers, and other unwanted actions

IOTWeek

Dublin — June 20-23, 2022

# Thank you very much for your participation

# and

# Please join us in the virtual workshop

# *mid-September!*

iotweek.org

# Agenda

IOTWeek
Dublin — June 20-23, 2022

Total 75mn

1.) European view
a. Introduction to the EU/US collaboration initiative (Max Lemke) 5mn
Rolf
b. Landscape of EU research in the area (Rolf Riemenschneider) 5mn

2.) US view
a. Importance to the US science and engineering mission (Gurdip Singh) 5mn
b. Intention to catalyze a long-term, enduring collaboration (not one-off projects or visits) (Gurdip Singh) 5mn

3.) Technical aspects (Marc Duranton and Jason Hallstrom) 15mn
Joint presentation on potential technical threads that might be pursued

4.) Next workshop and logistics (Max Lemke and Gurdip Singh) 10mn
Joint presentation on potential logistics (funding structure, timing)
(pending your availability, we were tentatively targeting the week of September 12th for the workshop)

5.) Discussion (all) 30mn
(split in to logistics and technical? 15mn + 15mn?)