

A Vision for Artificial Intelligence

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SECURE CONNECTIONS
FOR A SMARTER WORLD

Agenda

- What is AI?
- How is AI being used today?
- What is edge computing?
- AI and edge computing
- Predictions
- Next steps



Defining Common Terms

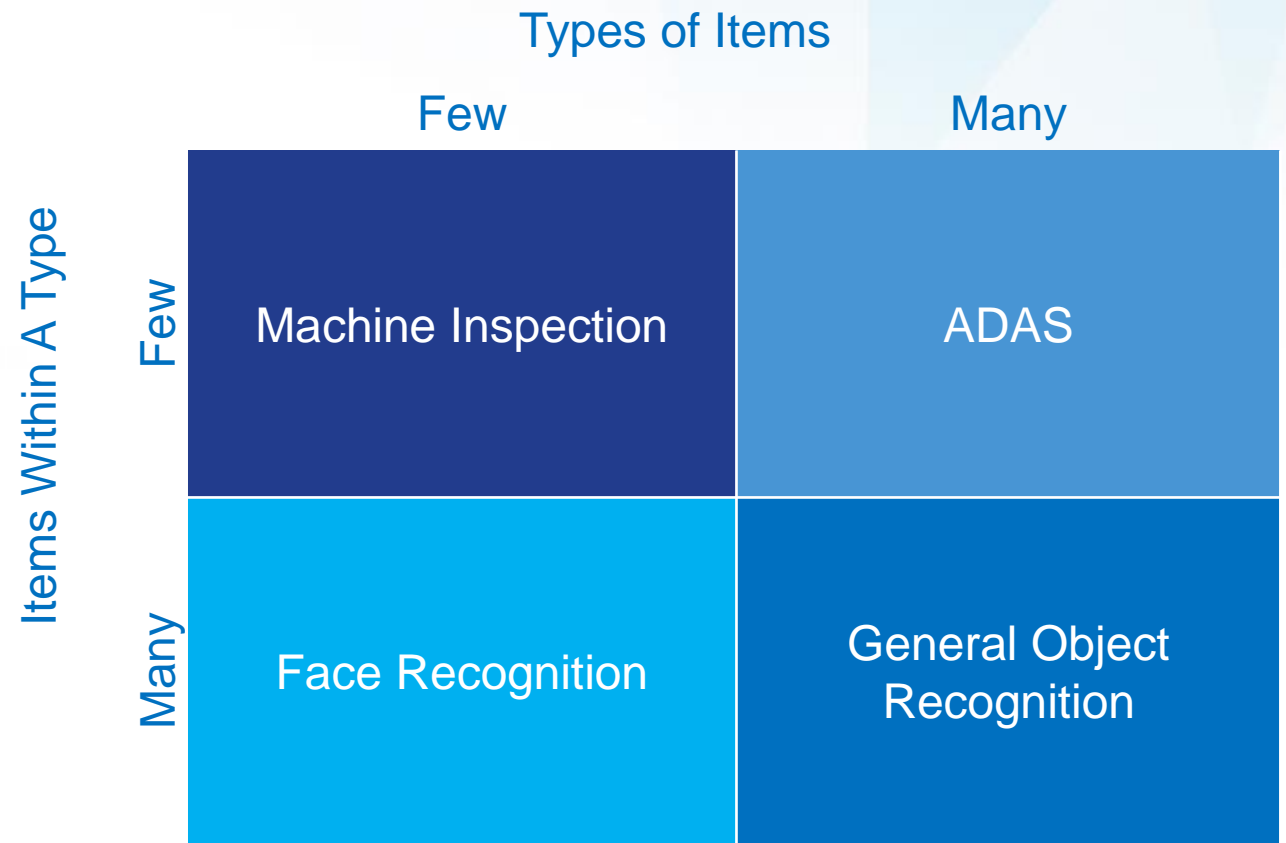
- **Artificial intelligence (AI)**
 - A computer performs tasks considered heretofore to require human intelligence
- **Machine learning (ML)**
 - Key term is *learning*: input data teaches the model how to function
 - Learning is typically supervised (the model is **trained** using input and the correct output)
 - Application of the trained model is called **inferencing**
 - But learning may be unsupervised (e.g., cluster analysis)
- **Neural network (NN)**
 - A class of ML algorithms
- **Deep learning**
 - ML using a big neural net

Neural Networks Are NOT The Only Type of AI/ML Algorithm



Similar AI Tasks Have Important Differences

- **ADAS**
 - Identifies pedestrians, cars, signs, lane markings, obstacles, etc
 - Regardless of who a pedestrian is, it won't run him over
- **Face recognition**
 - Only identifies faces
 - Differentiates many people
- **Machine inspection**
 - Only knows widgets
 - Only classifies as good or bad



Why AI?



ARTIFICIAL
INTELLIGENCE

Faster than human analysis

Cooler under pressure

Analyzes more data than humanly possible

Better insights than man-made models

Reduces **cost**, increases **revenue**

Increases **safety**

Why AI?

Events that are impossible
to predict today will become
Predictable



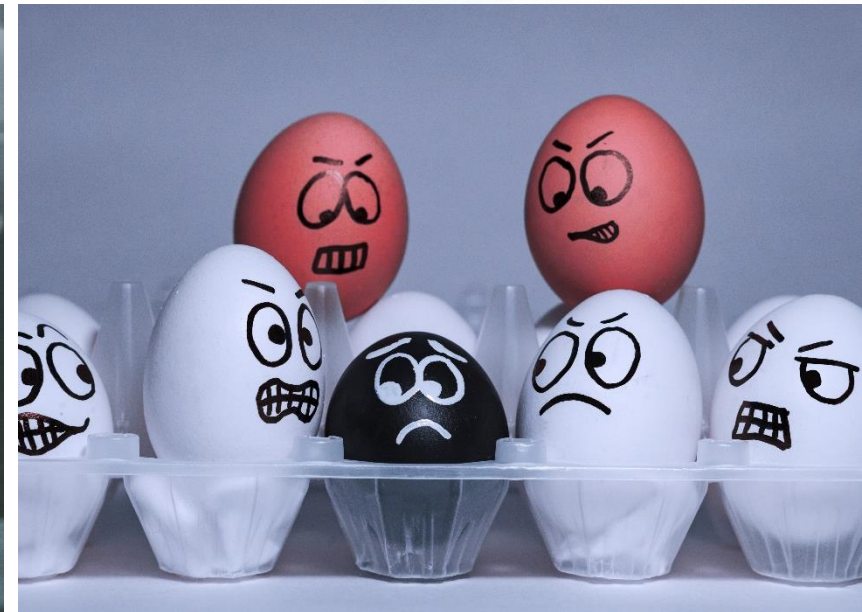
Issues with AI



Not provably
correct

Sometimes fatally
wrong

Biases possibly
trained in



An Imperfect Grouping of Applications

Evaluate/Recognize

- Vision-based (identify what's in a picture)
- Speech recognition
- Textual analysis (NLP and not-quite NLP)
- Anomaly detection

Decide

- Games (e.g., Go, chess)
- ADAS
- Recommendation engines
- Robotic process automation



Medical

Echocardiography analysis
(e.g., Ultromics)

Reading CT scans
(e.g., Optellum), x-rays, etc

Examine blood for bacteria

Answer questions, recommend
treatment (e.g., Watson)

Psychological evaluation
(e.g., Cogito)



Finance

Fraud and money laundering detection

Customer profiling for cross-selling

Customer-service chatbots

Risk analysis

Analysis of earnings calls

Contract analysis

Back-end automation



Military

Aerial surveillance

In-building surveillance

Target identification

Soldier training



Other Business Use

Warehousing: physical inventory, pick & place robots

Inspection: powerlines, products, received goods

Security and surveillance

HVAC control (e.g., DeepMind and data centers)

Product recommendations

Headline and photo selection

Emotional analysis of focus groups (e.g., Affectiva)

Malware detection (e.g., Deep Instinct)

Insurance claims automation



Transportation

ADAS

Driver alertness

Driver behavior assessment

V2X

Equipment monitoring



Consumer

Smart speakers (e.g., Echo)

Doorbells and locks (e.g., Ring)

Remote controls (e.g., Caavo)

Augmented reality (AR) games
(e.g., Pokemon)

Thermostats

Baby monitors (e.g., Cocoon)

Edge Computing Definition

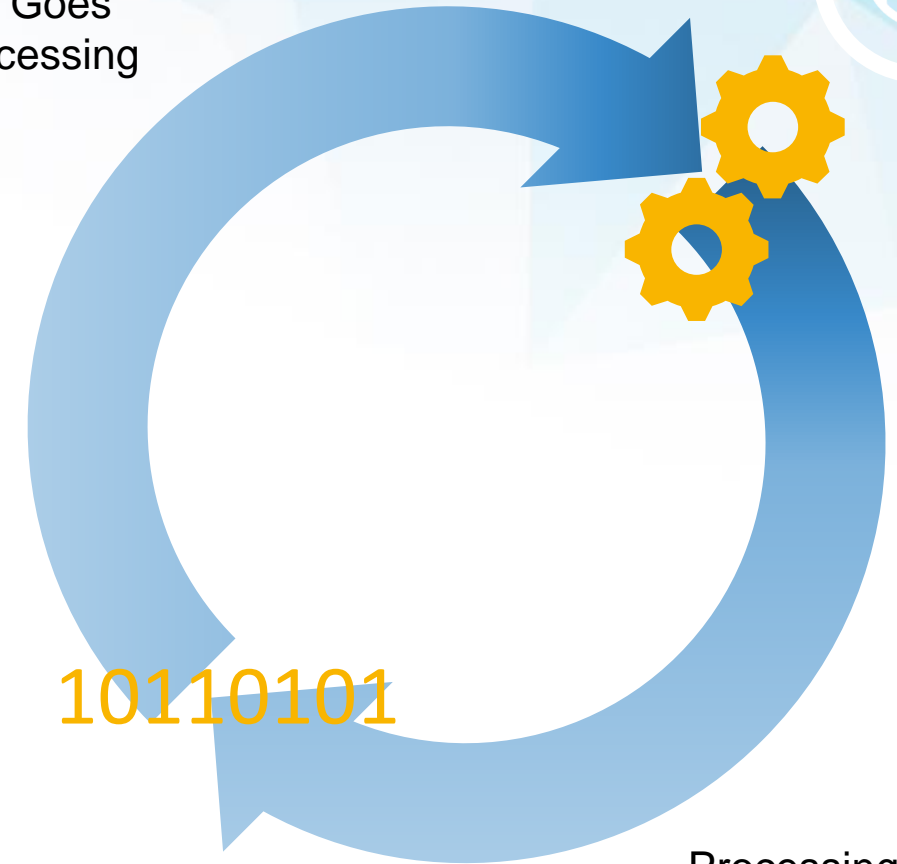
Inclusive

- Computing near the source/sink of data
- AKA moving computing to the data

Narrow

- Applying cloud-computing techniques outside the data center
 - Soft provisioning of compute, storage, networking
 - Virtualization and containerization
 - Service-oriented architecture
 - Orchestration

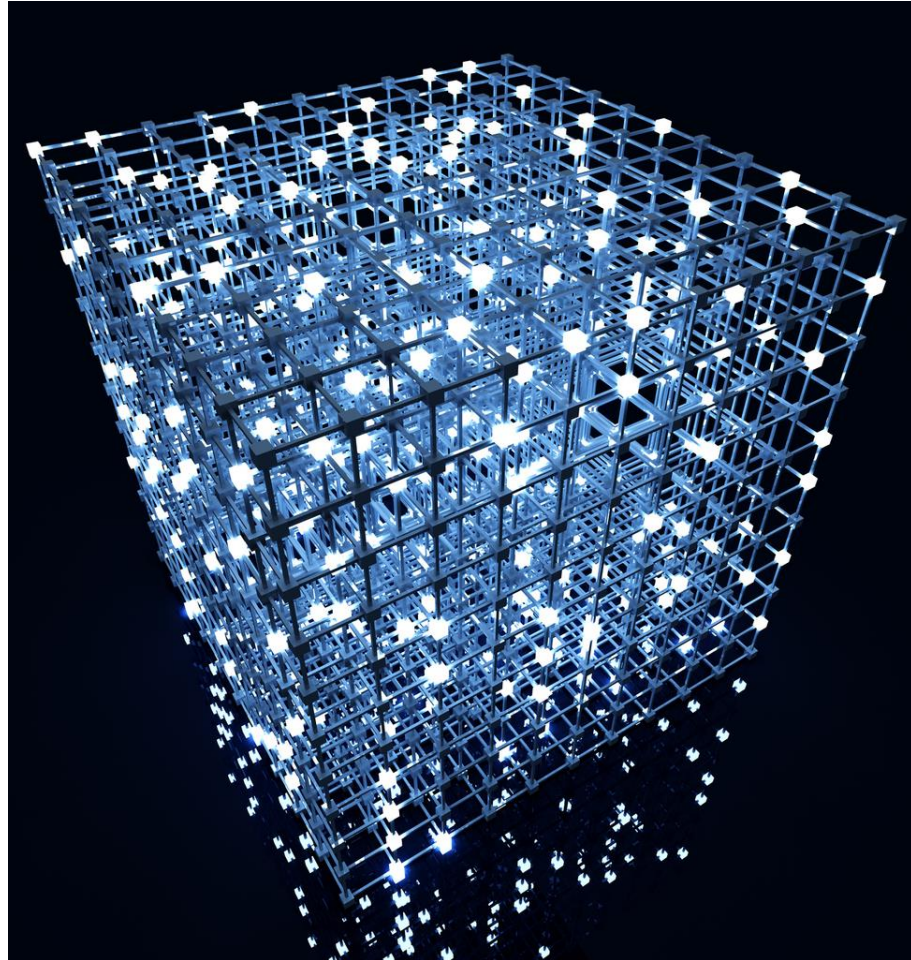
Data Goes
to Processing



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Processing
Goes to Data

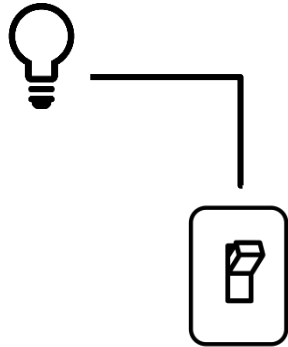
Edge Computing Topologies



- **Self-contained:** Edge node does all computation for a specific machine or IoT endpoint
- **Hub and spoke:** One edge node services multiple machines/endpoint
- **Peer-to-peer:** Loads migrate among nodes with free capacity or the cloud
- **Hierarchical:** Edge node shares computation, example:
 - Cloud trains models
 - Endpoint classifies observations (e.g., recognizes objects) based on these models' output
 - Edge node decides on actions based on the output of classification

AI Is Transiting From Stage 2 To Stage 3 of the Edge Revolution

1. Precursor



Local
Command
and Control

2. Cloud Computing



Functions Added
Via Cloud
Computing

3. Re-Localization



Functions in
Cloud Integrated
Locally

4. Local Cloud



Cloud APIs
Implemented
Locally

Pre-Edge Computing

True Edge Computing

When is AI Suited to Edge Computing?



Reduce Data
Transferred

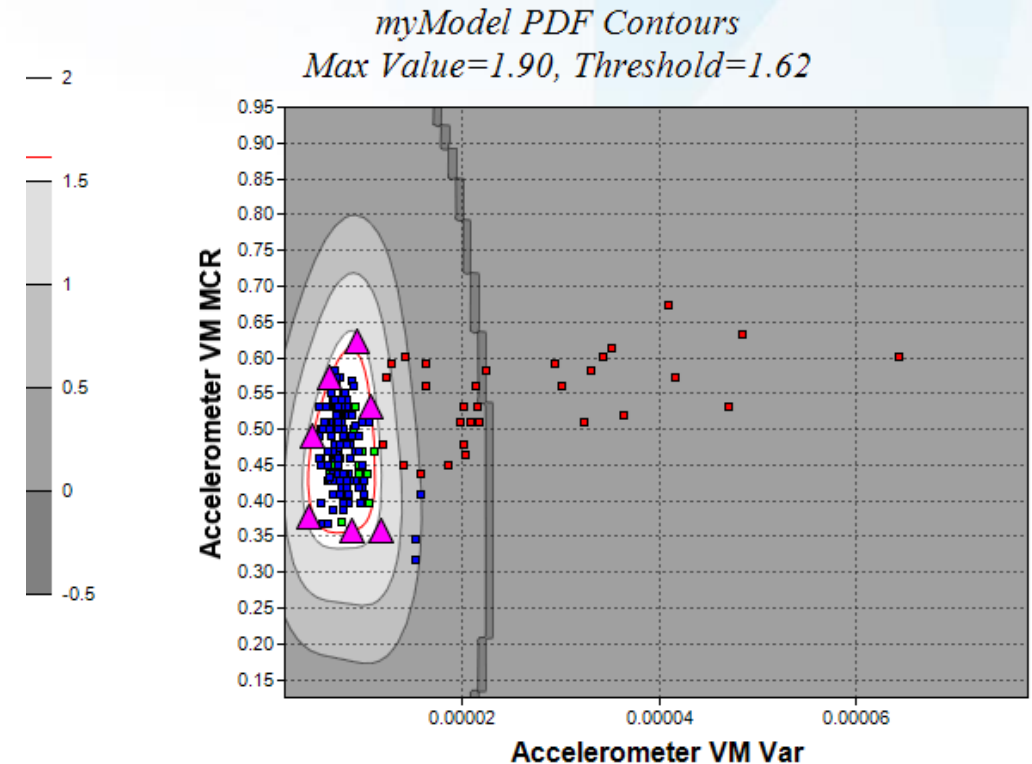
Reduce
Latency

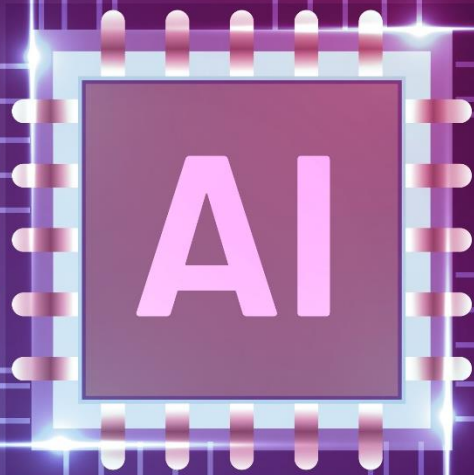
Secure Data
Onsite



AI at the Edge: Inexpensive, Ubiquitous, and Fast

- SVM for anomaly detection runs on NXP microcontrollers
- Object detection/classification runs unaccelerated on a single Layerscape processor
- AI acceleration is coming to microcontrollers and multicore processors
 - 10x performance improvement
 - 20x efficiency improvement





AI in Even Low-Cost Processors

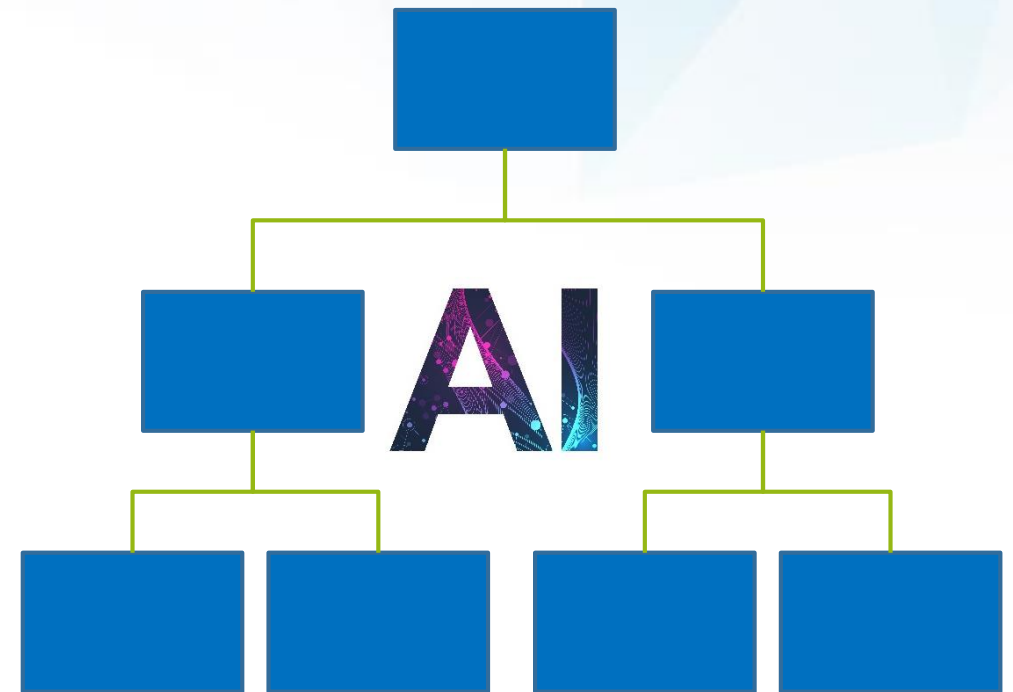
Classification plus image-processing will yield semantic media formats

AI will do stuff that digital or even analog circuits do today

Video, speech, and text analysis and NLP will appear in unusual places

Collaborative Edge Topologies Will Amplify AI

- End-node processor will do first-level classification, such as: object location within field of view, type, unique ID
- Second-level processor will do additional classification, predict objects' next moves
- Third-level processor will take action or stitch together second-level processors' assessments





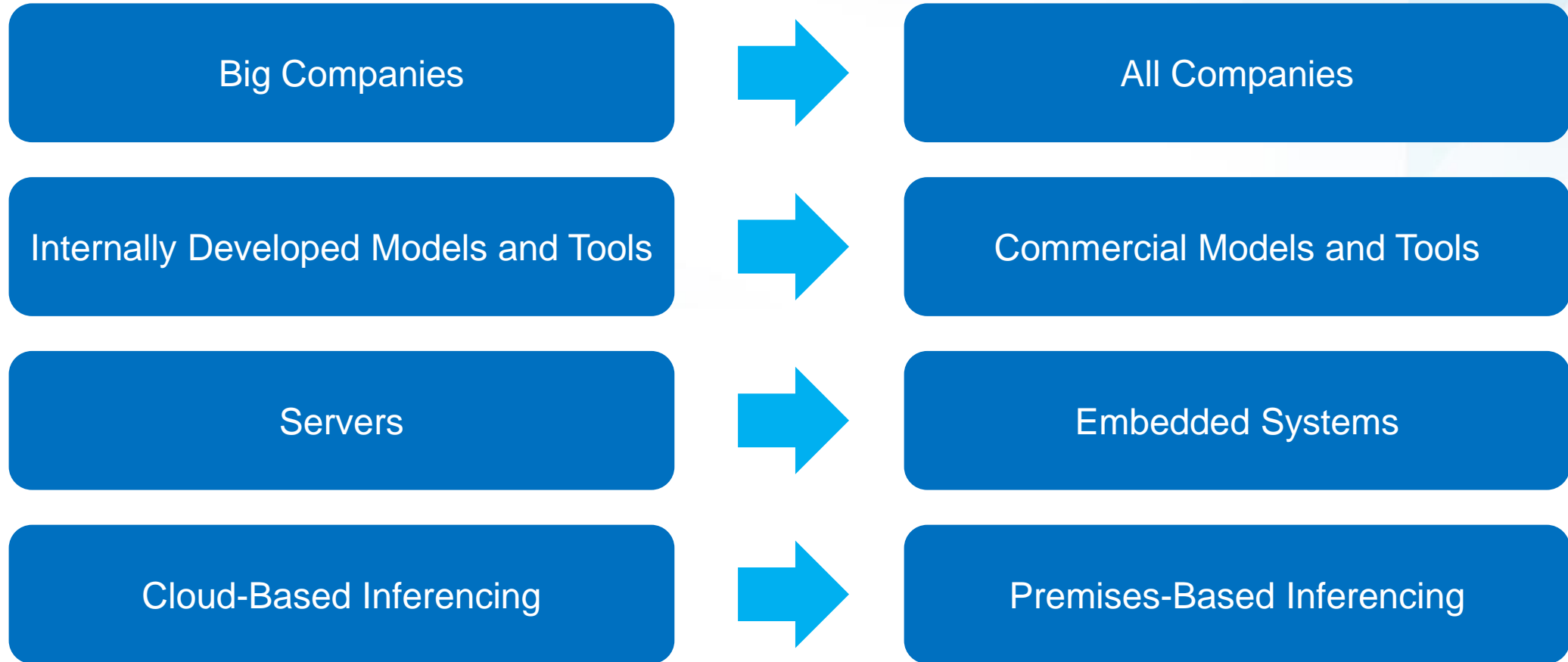
Networking AI Systems Breeds New Edge-Based Applications

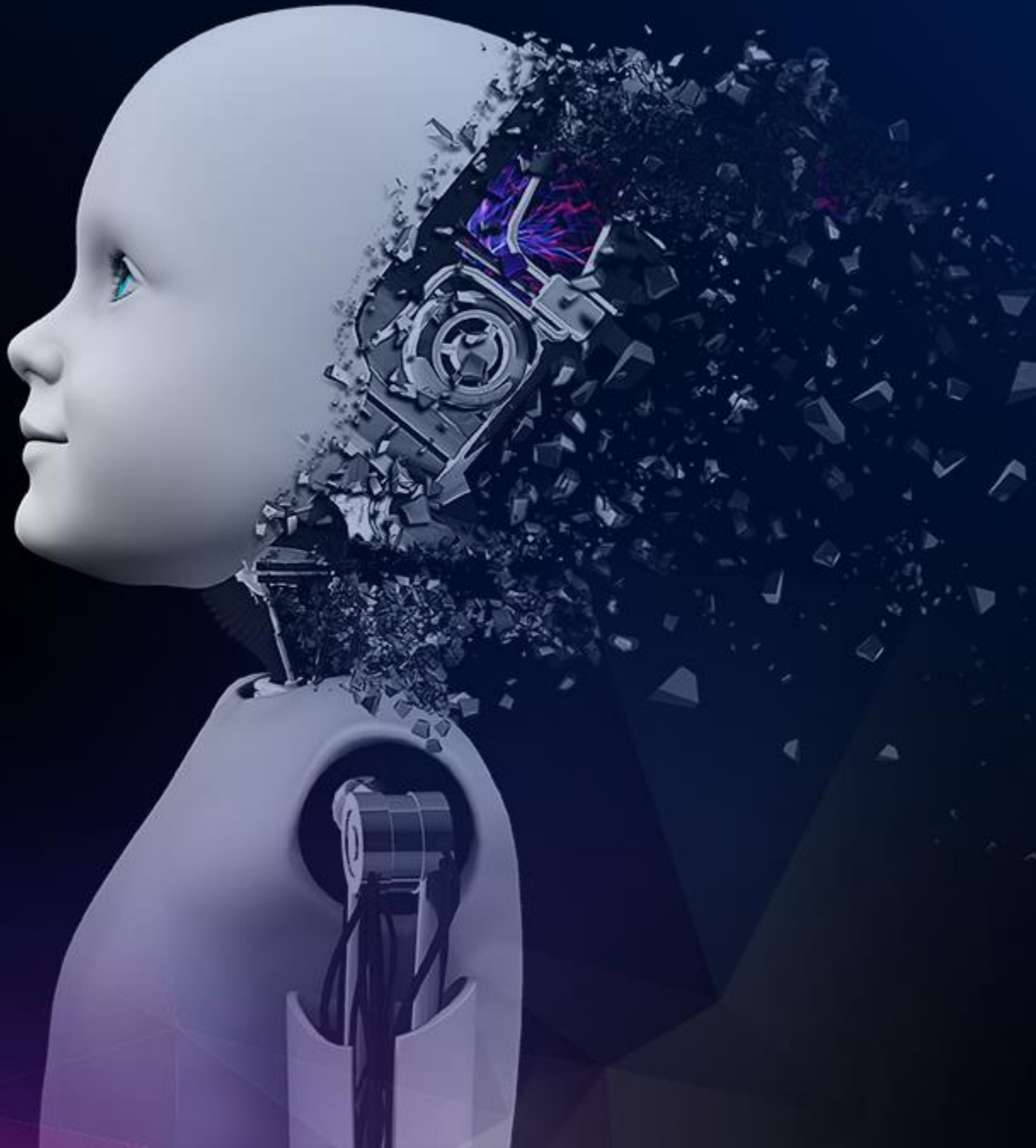
HVAC starts cooling your office when security camera says you've arrived

Security camera spies overheating coffee pot and warns fire system

Emotion recognition system feeds into driver-performance system

Edge Computing Will Change the AI Industry





Key Take-aways

AI is coming to edge computing

Collaborative topologies amplify AI's power

Networking yields new applications for AI

Fun Predictions

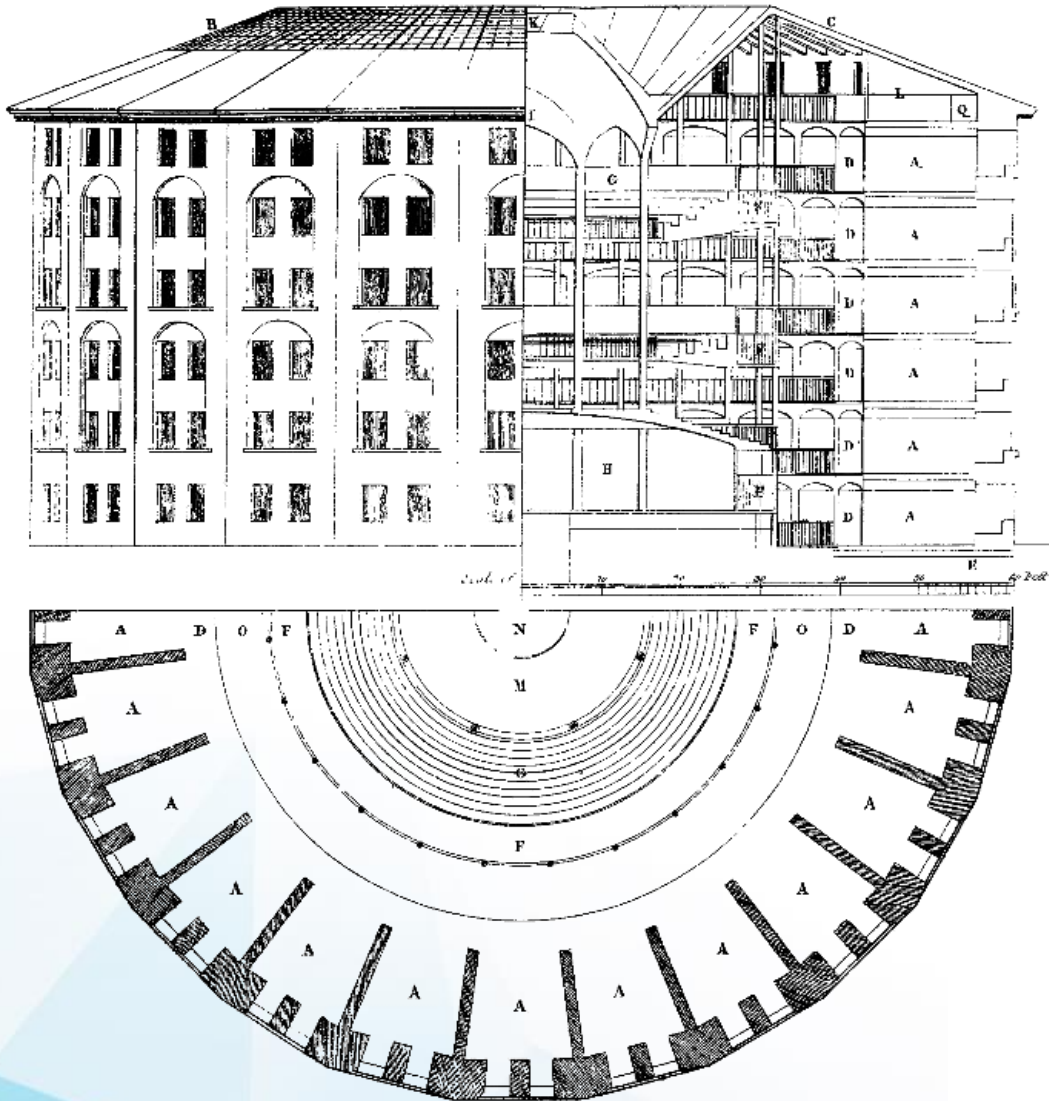
Augmented reality glasses will return

Star Trek's tricorder will be invented

Dangerous jobs will be automated



PANOPTICON



Not-So-Fun Predictions

- People will give up on explainable AI
 - We'll live in a panopticon
 - Jobs requiring human interaction or knowledge will be automated
 - Driving, deliveries, cashiers, nursing, doctors, lawyers
 - Productivity (\$ output per worker) gains and employment reduction comparable to seen in automation of manufacturing
- Cost disease cured but at what expense?

We Cannot Predict Specifically How AI Will Be Used

AI Is Stupider Than it Seems



People Aren't Good At Predictions



Tech Advancement Is Nonlinear



Next Steps for Suppliers

Develop an ecosystem of IP,
hardware, and software

Integrate AI acceleration



Next Steps for Developers

Recognize a lot of AI can be done with just CPUs

Explore hierarchical and peer-to-peer topologies

Prepare for a 10x performance gain





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