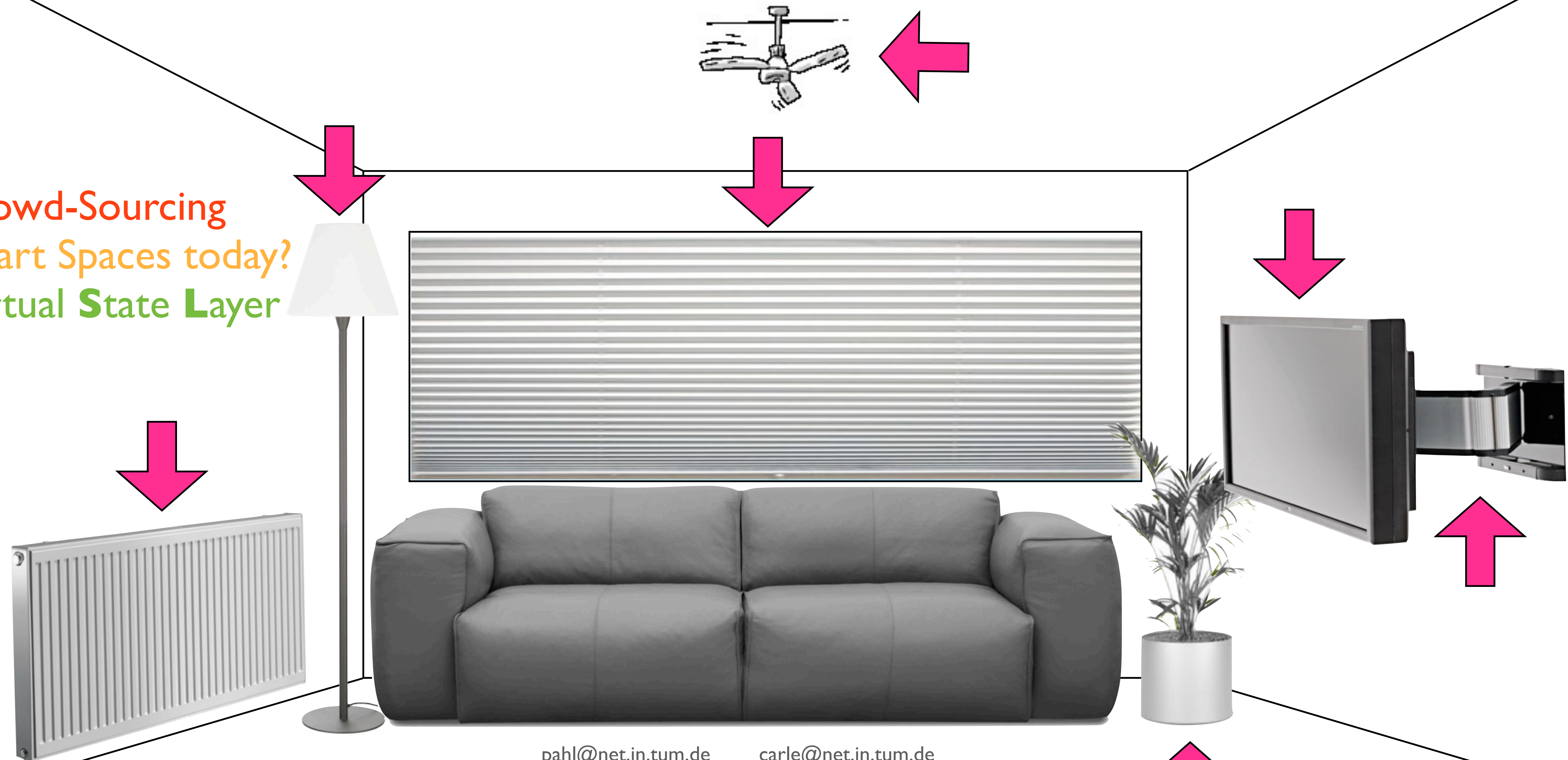


Crowd-Sourcing
Smart Spaces today?
Virtual State Layer



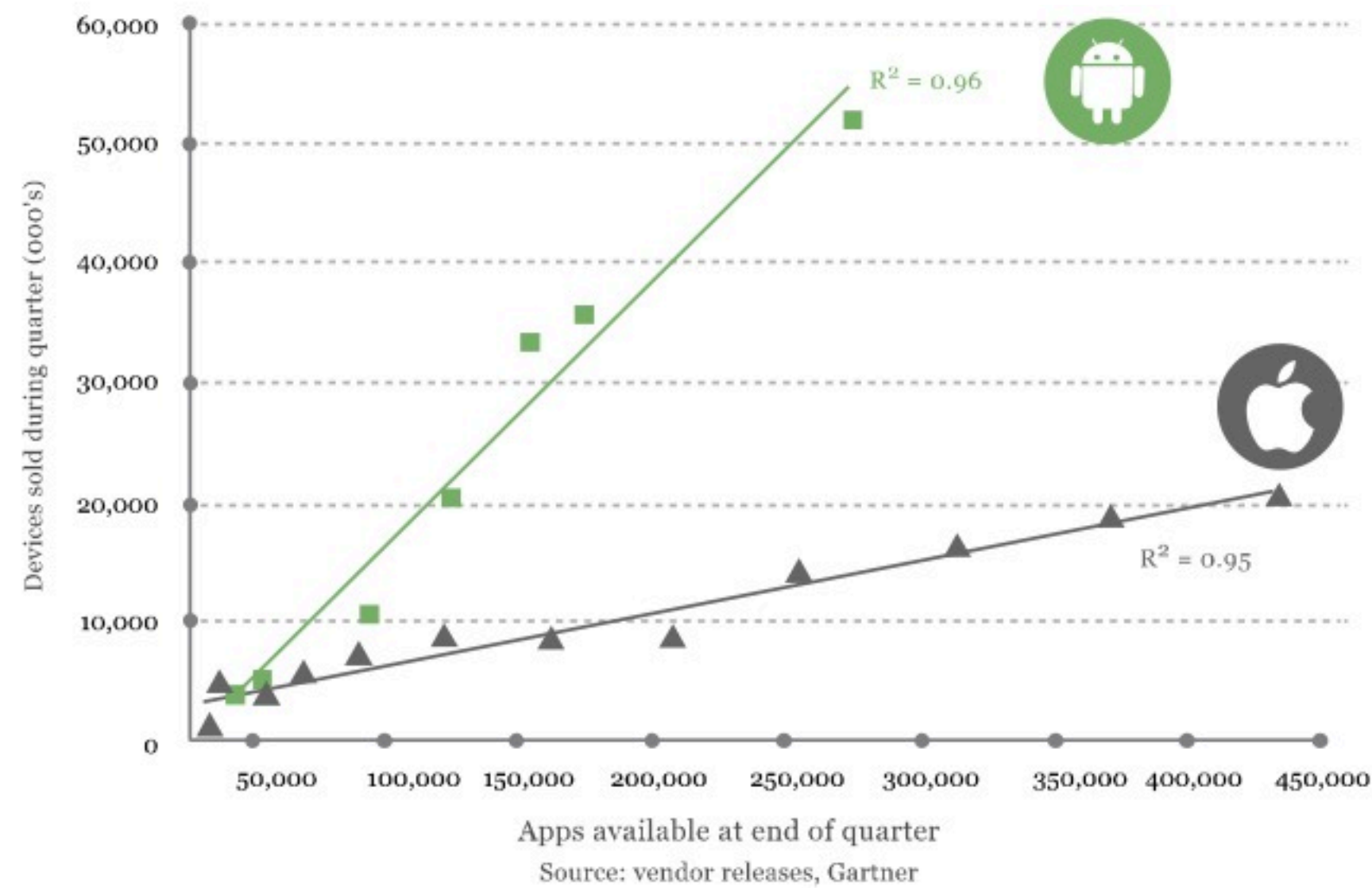
pahl@net.in.tum.de carle@net.in.tum.de

Marc-Oliver Pahl and Georg Carle Technische Universität München

The Missing Layer - Virtualizing Smart Spaces

Devices sold during quarter (000's)

Apps available at end of quarter



Developer investment in Android, iOS, WP7

Platform	Publishers ⁴	Average apps/user ⁵	Mindshare ⁶ (% of developers using the platform)
Android	70,000	4.1	67%
iOS (iPhone)	101,000	4.1	59%
iOS (iPad)	36,000	3.6	N/A
Windows Phone 7	7,000	3.6	36%

⁴Xyologic, USA market, August 2011 ⁵Xyologic, USA market, August 2011

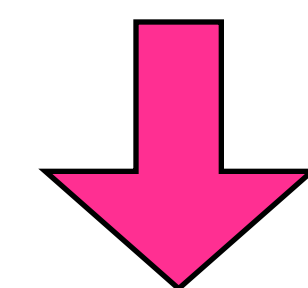
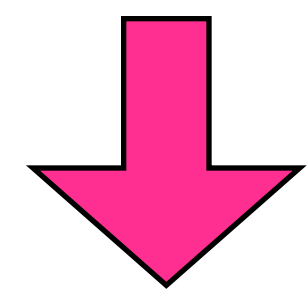
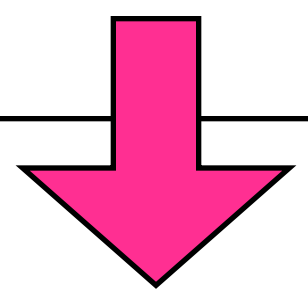
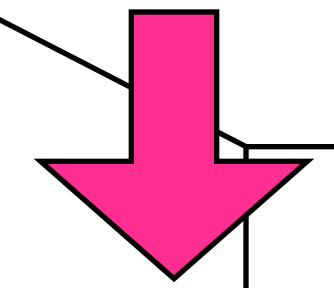
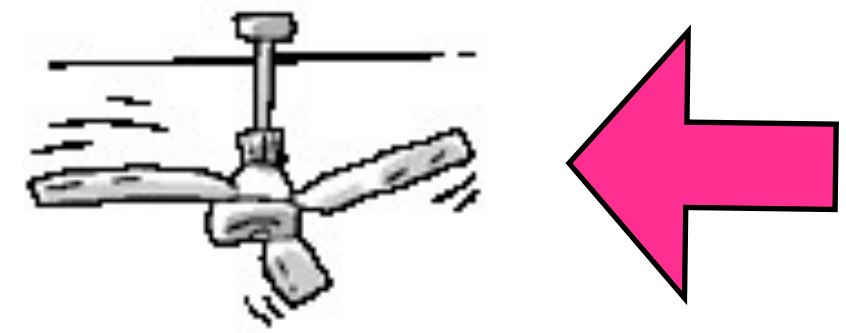
Mobile Software: The Clash of Ecosystems | www.visionmobile.com/Ecosystems | November 2011
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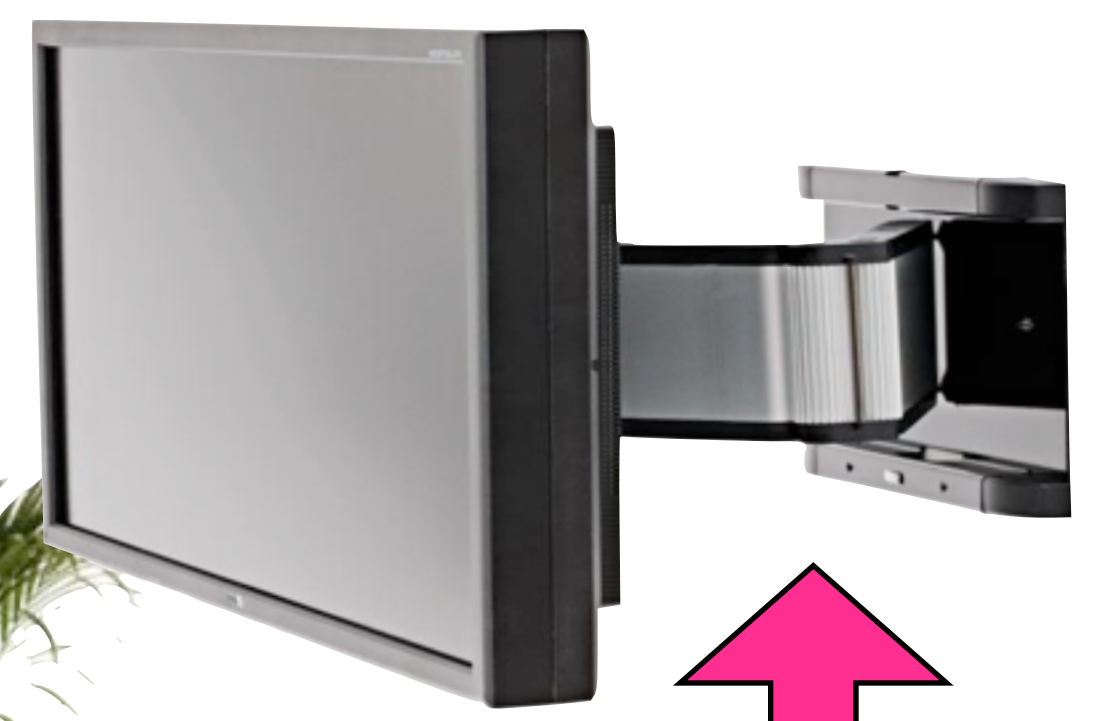
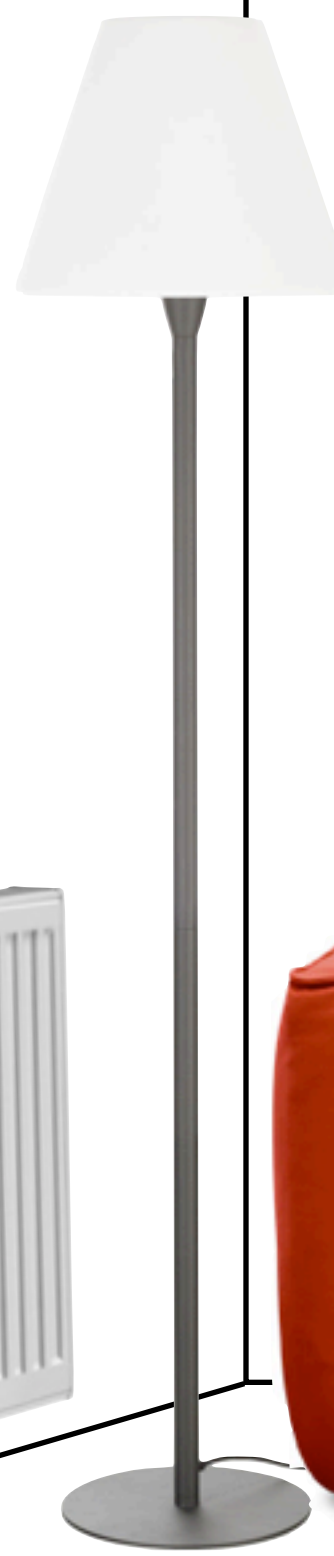
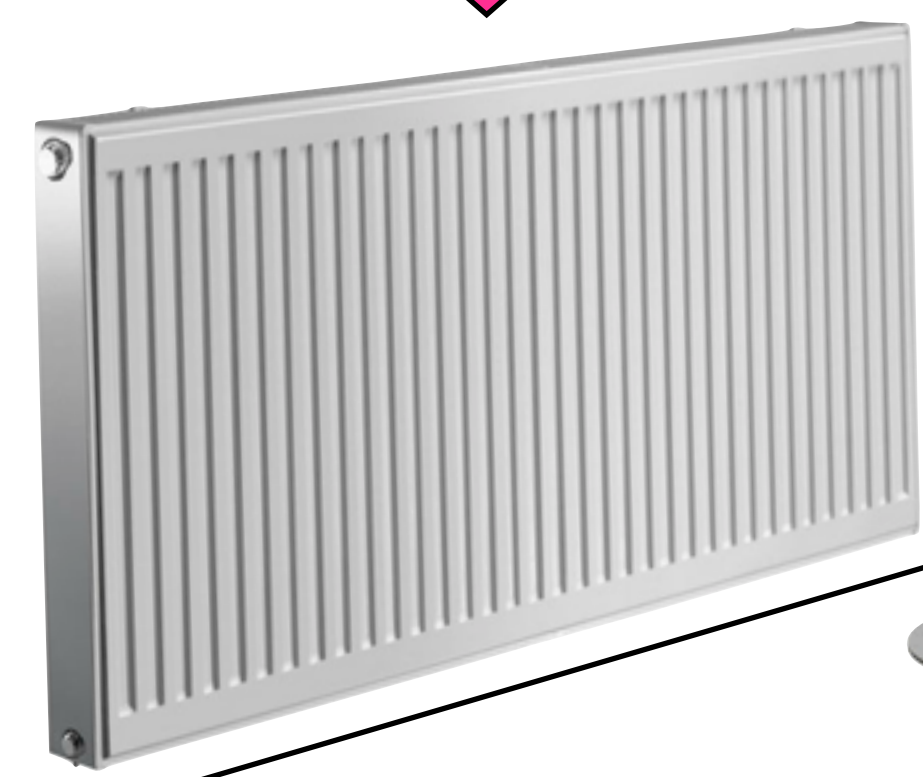
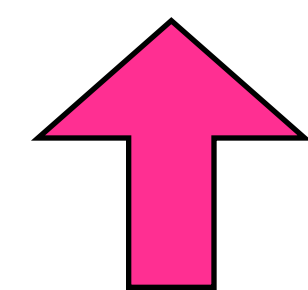
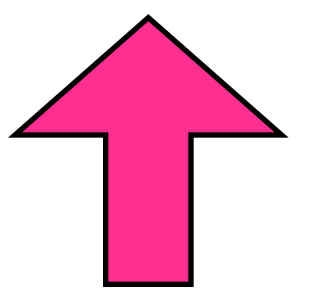
Wouldn't it be cool to have crowd-sourced development for smart spaces too?



Lots of developers produce lots of applications



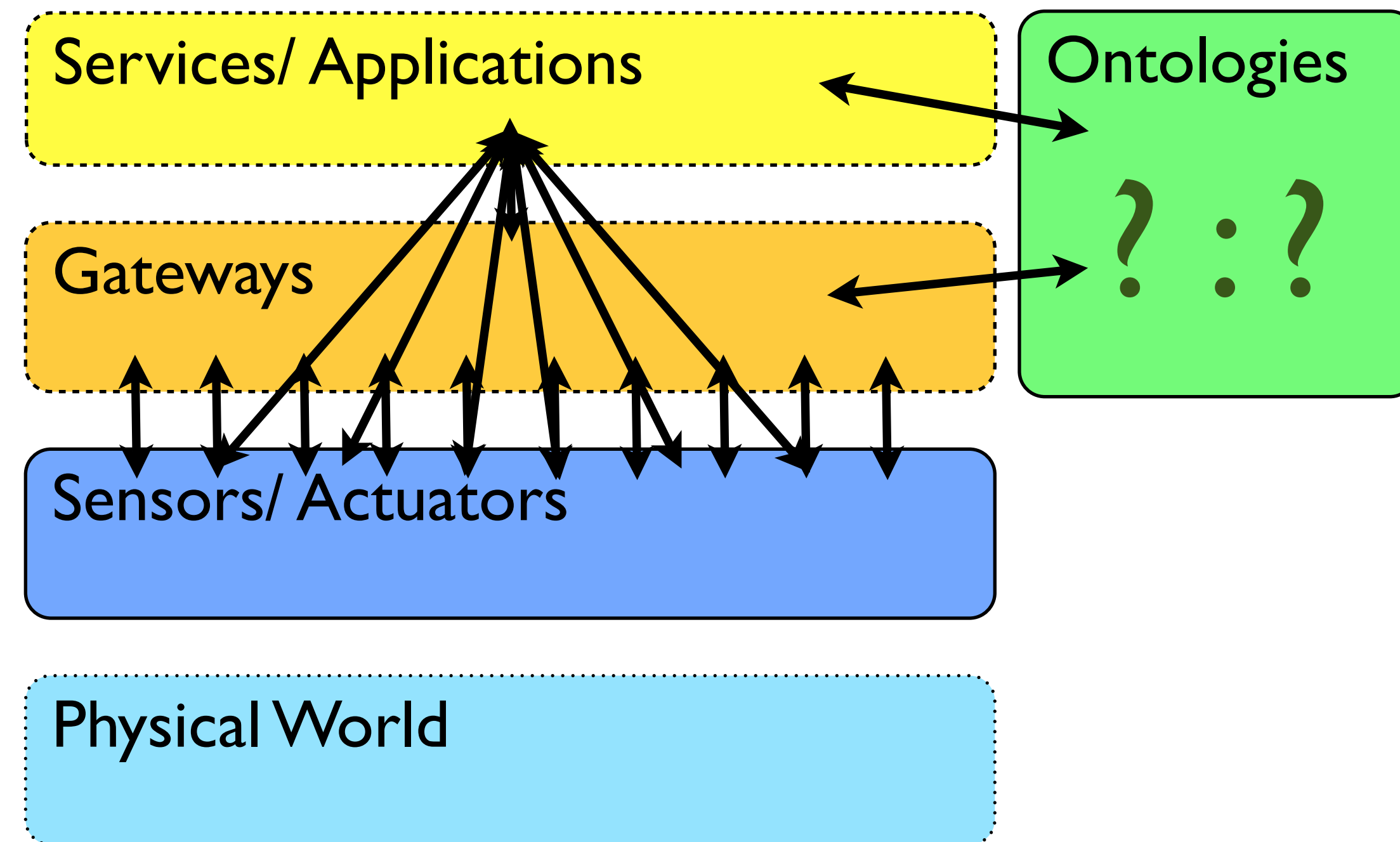
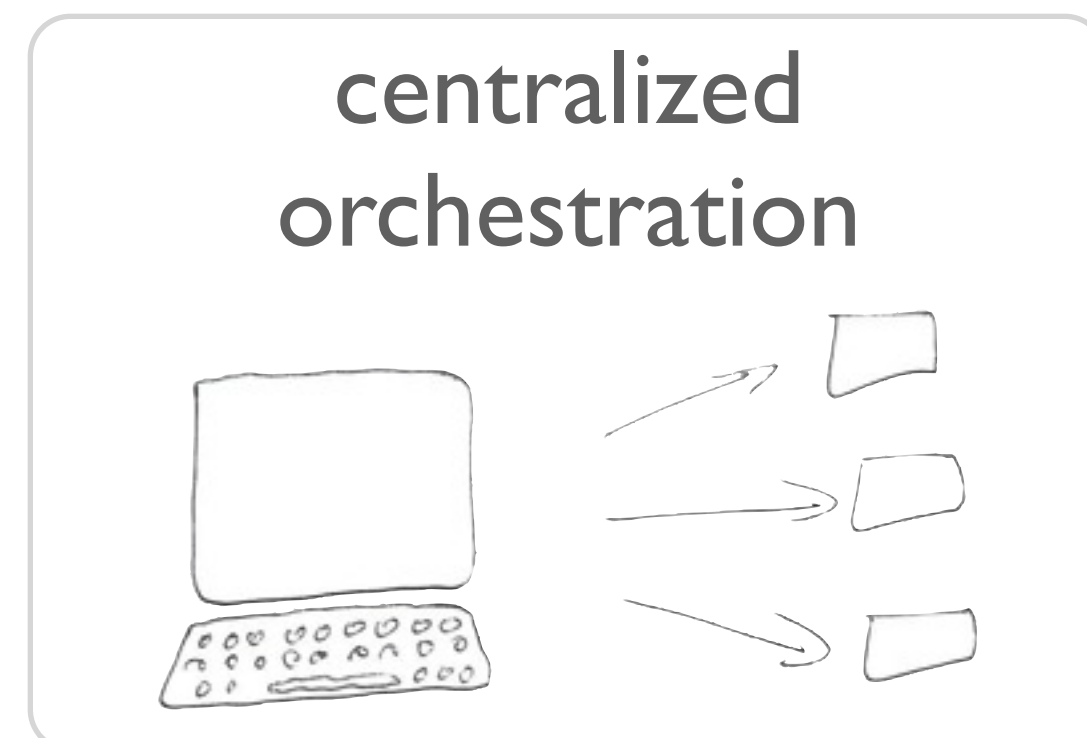
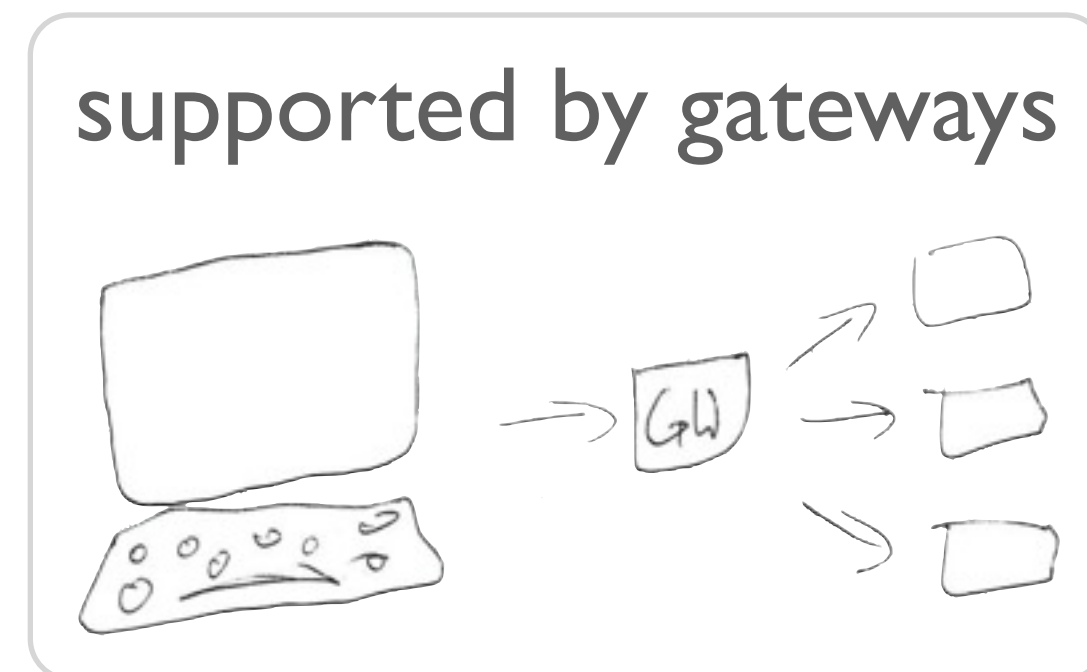
- ① Homogeneous API
- ② Portable Applications
- ③ Dynamic Extensibility
- ④ Simple Development of Services



Research questions?

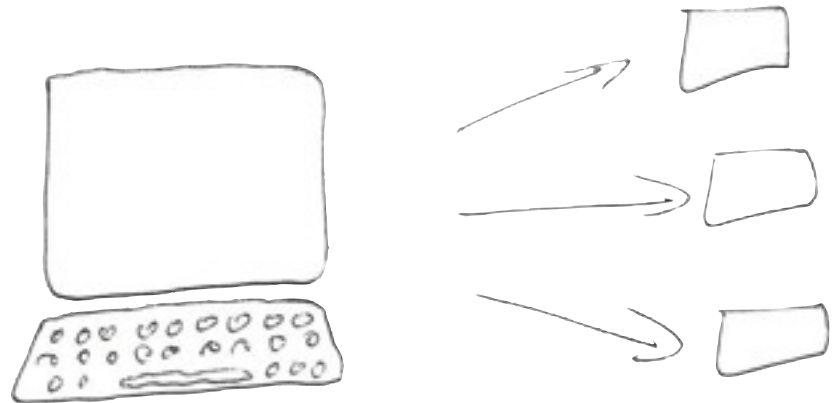
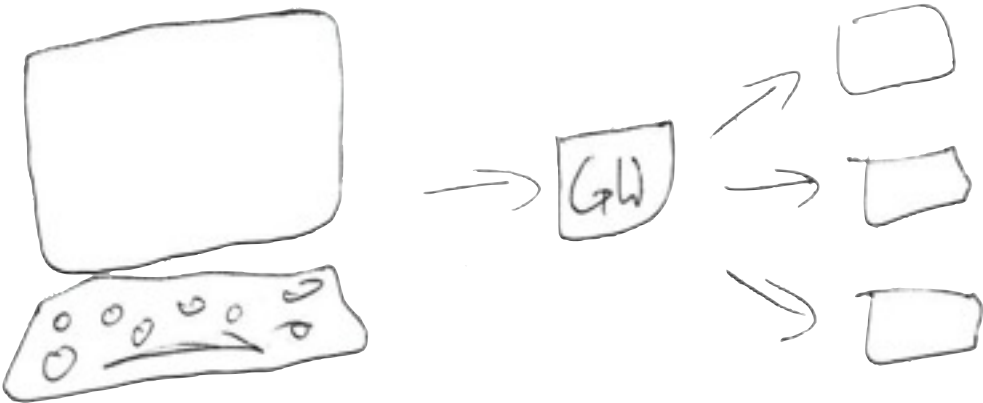

- ① How can a **homogeneous API** to heterogeneous devices in smart spaces look like?
- ② How can the **portability** (instance-comprehensive use) of applications be supported?
- ③ How can **dynamic extensibility** be realized?
- ④ How can the **development** of applications for smart spaces be supported to **facilitate** it?

What kind of support for software orchestration do we have today?



[11] Y.-D. Bromberg, P. Grace, L. Reveillere, and G. S. Blair, "Bridging the interoperability gap: overcoming combined application and middleware heterogeneity," in *Middleware'11: Proceedings of the 12th ACM/IFIP/USENIX international conference on Middleware*. Springer-Verlag, Dec. 2011.

[9] C. Bettini, O. Brdiczka, K. Henricksen, J. Indulska, D. Nicklas, A. Ranganathan, and D. Riboni, "A survey of context modelling and reasoning techniques," *Pervasive and Mobile Computing*, vol. 6, no. 2, pp. 161–180, Apr. 2010.

	centralized orchestration	supported by gateways	abstraction via ontologies
API Homogeneity	-	○	+
App Portability	--	-	+
Dyn. Extensibility	-	○	○
Service Simplicity Control-, Gateway-	-	○ +/-	○ +/-
			

Which could be a good abstraction?

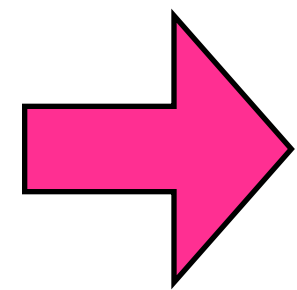
State!

$\langle L^*, \text{luminance} < 1000\text{Lx}, \text{light_on}() \rangle$



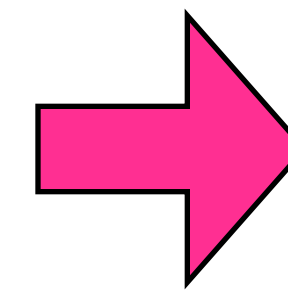
perception

event



cognition

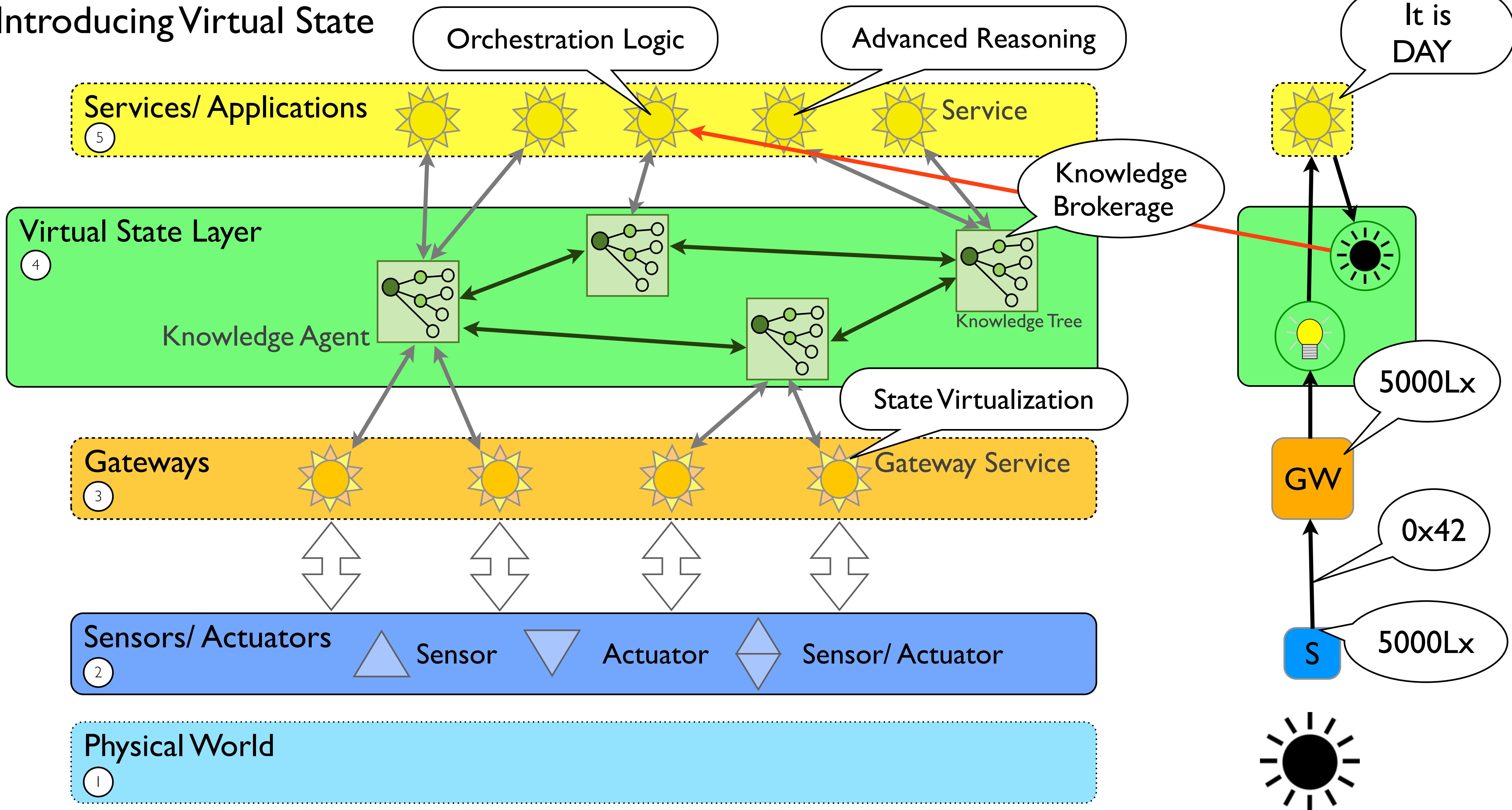
condition



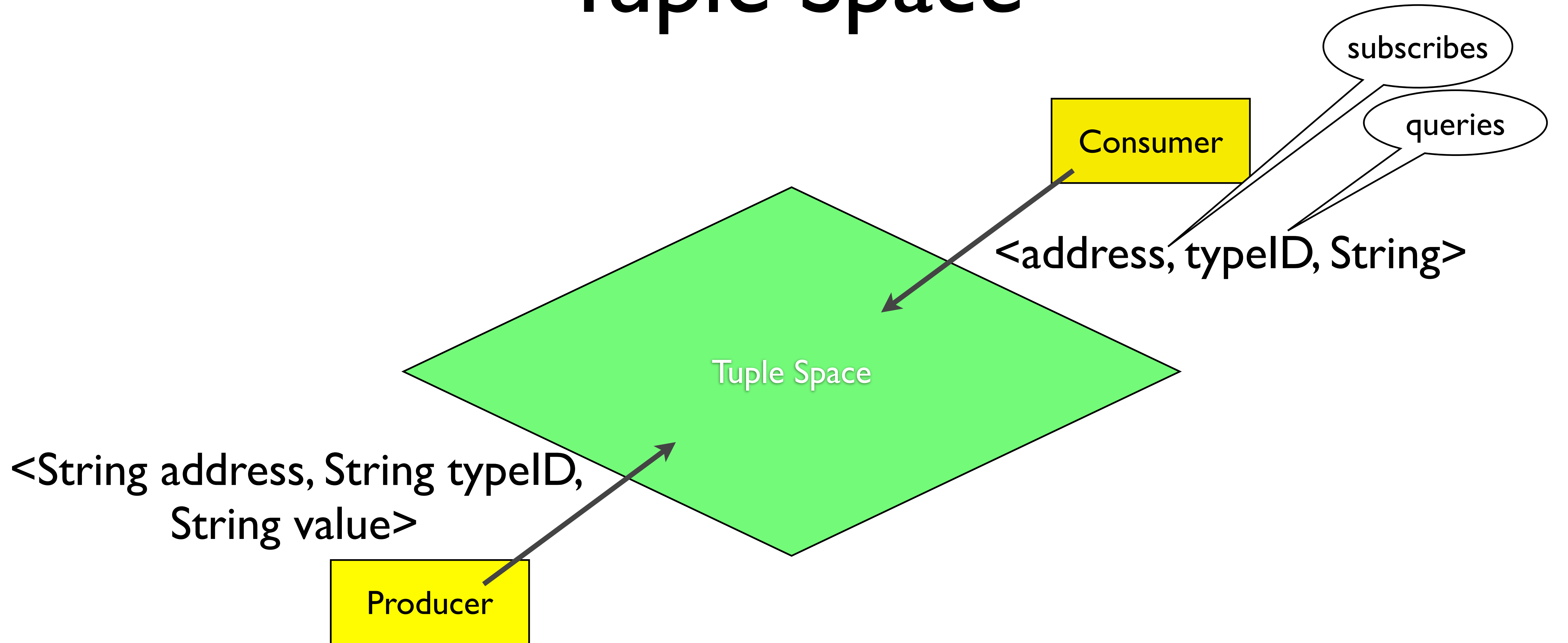
action

action

Introducing Virtual State



Tuple Space



E.g.: Linda, JavaSpaces, TSpaces, ...

Virtual State Layer Tuple Space

- Full spatial and temporal decoupling
- Data-type-based search
- Unified interface: search, get/set, subscribe

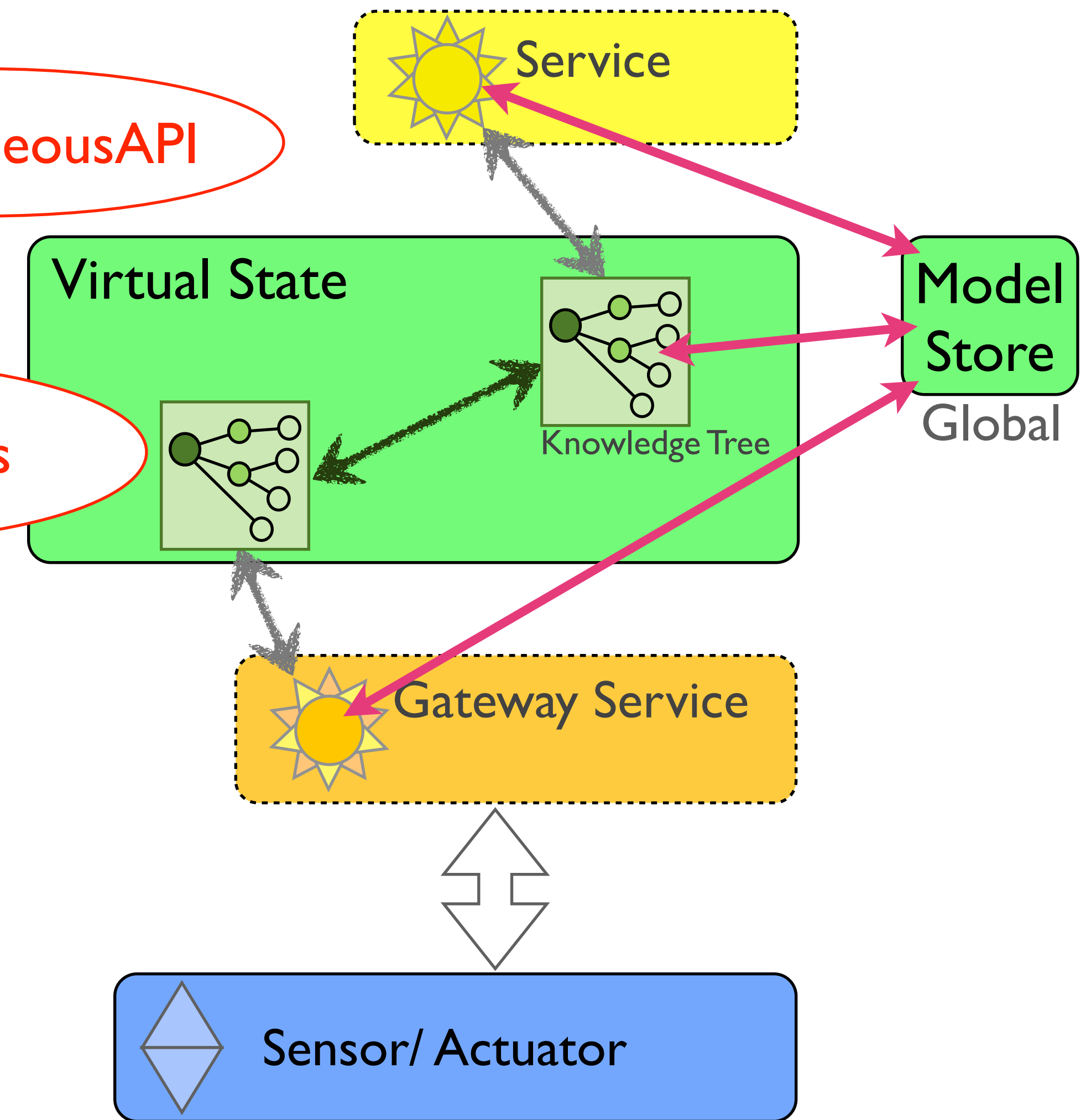
- Hierarchically structured tuples
 - Semantical locator/ID split via type-based search
 - Multi-inheritance
 - Shared global data-type repository for convergence (Model Store)
 - Dynamically extensible data model

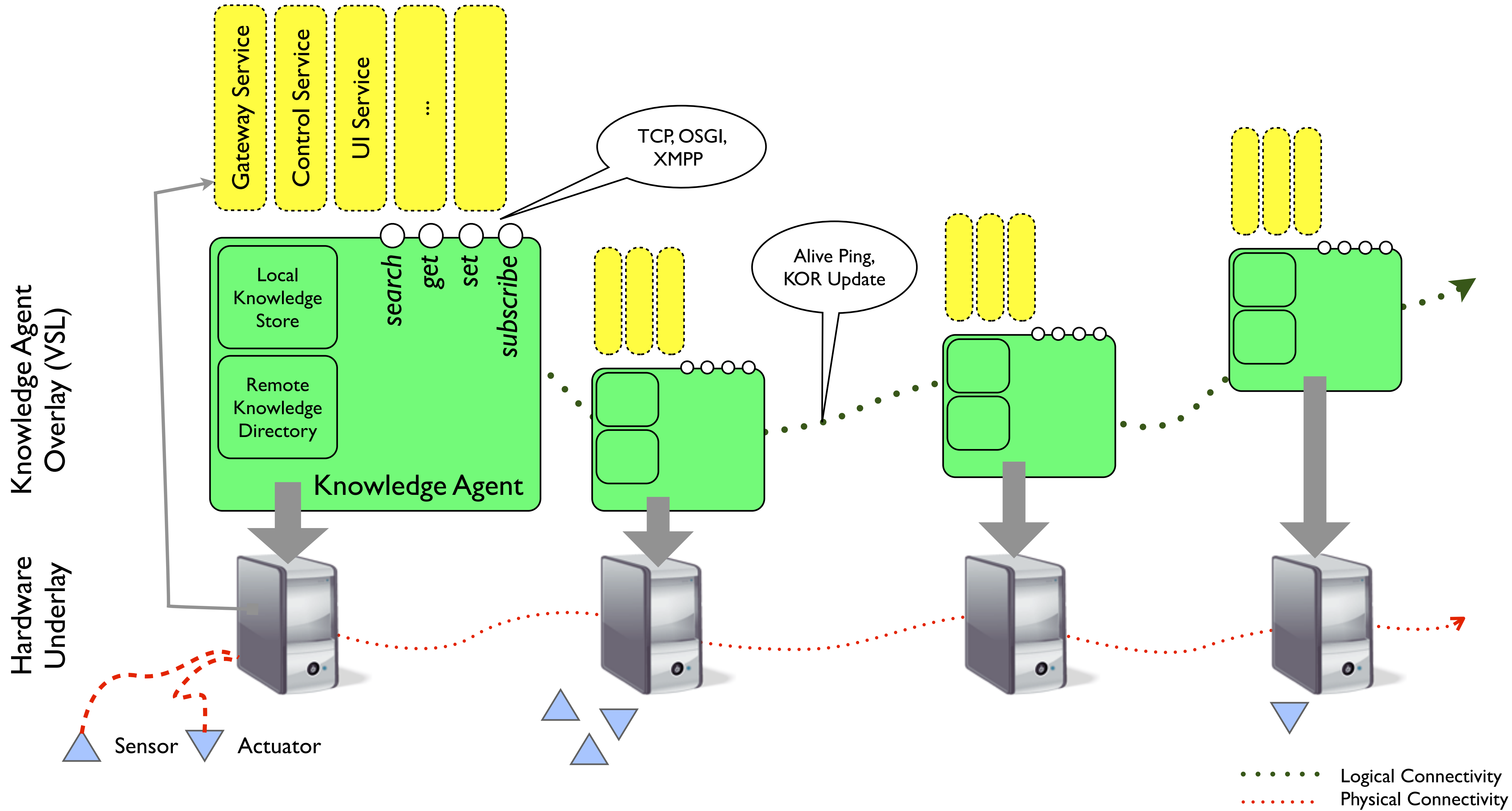
- Address-based subscriptions

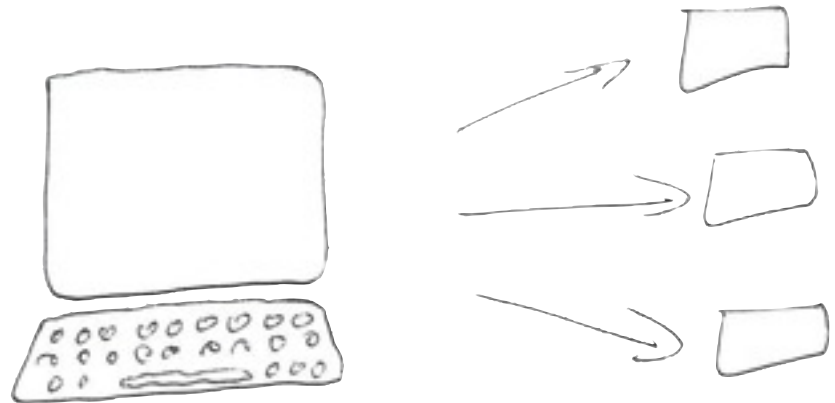
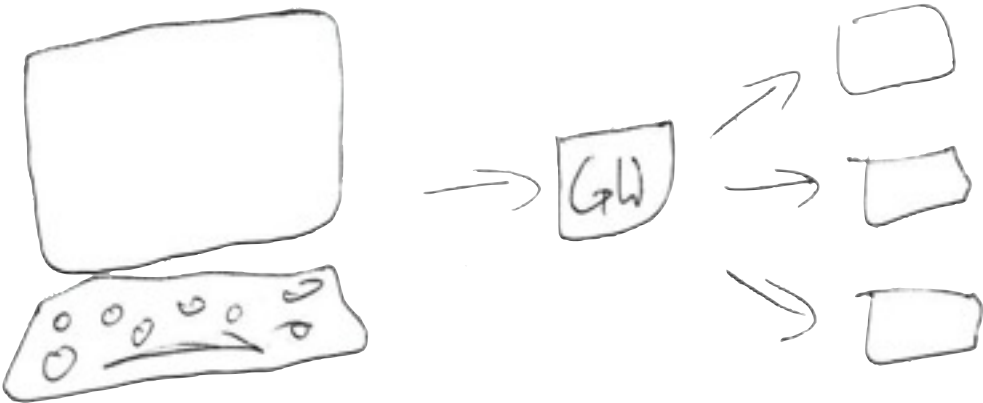

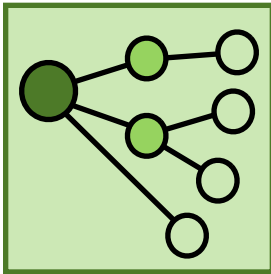
HomogeneousAPI

Portable Apps

Dynamic Extensibility





	centralized orchestration	supported by gateways	abstraction via ontologies	Virtual State Layer
API Homogeneity	-	○	+	+
App Portability	--	-	+	+++
Dyn. Extensibility	-	○	○	++
Service Simplicity Control-, Gateway-	-	○ +/-	○ +/-	+ +/-
				

How do orchestration tasks look like?

$\langle L^*, \text{luminance} < 1000\text{Lx}, \text{light_on}() \rangle$

L*-NotificationHandler:
If (**luminance < 1000Lx**) then
light = on;



V i r t u a l S t a t e L a y e r

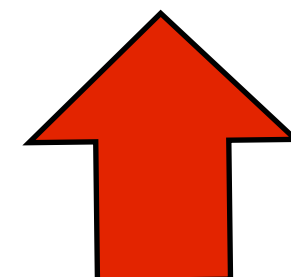
with the VSL

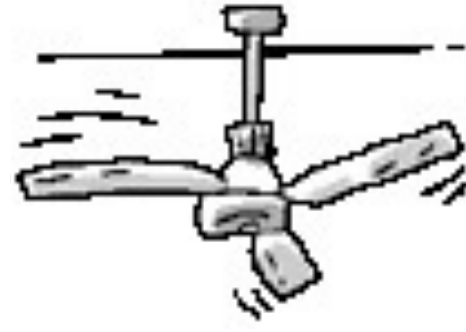


V i r t u a l S t a t e L a y e r

The **Virtual State Layer** is part of the Distributed Smart Space Orchestration System (DS2OS)

- Provides autonomous knowledge storage and brokerage
- Written in Java
- Simple API: get/ set & publish/ subscribe
- Can be used via TCP socket, (OSGI, XMPP)
- GIT repository at <http://www.ds2os.org/>, <http://dssos.net.in.tum.de/>





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Smart Spaces today?
Virtual State Layer

<http://ds2os.org/>

Thank you for your attention!
Questions?

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