

# Multimodal Appliance Cooperation based on Explicit Goals: Concepts & Potentials

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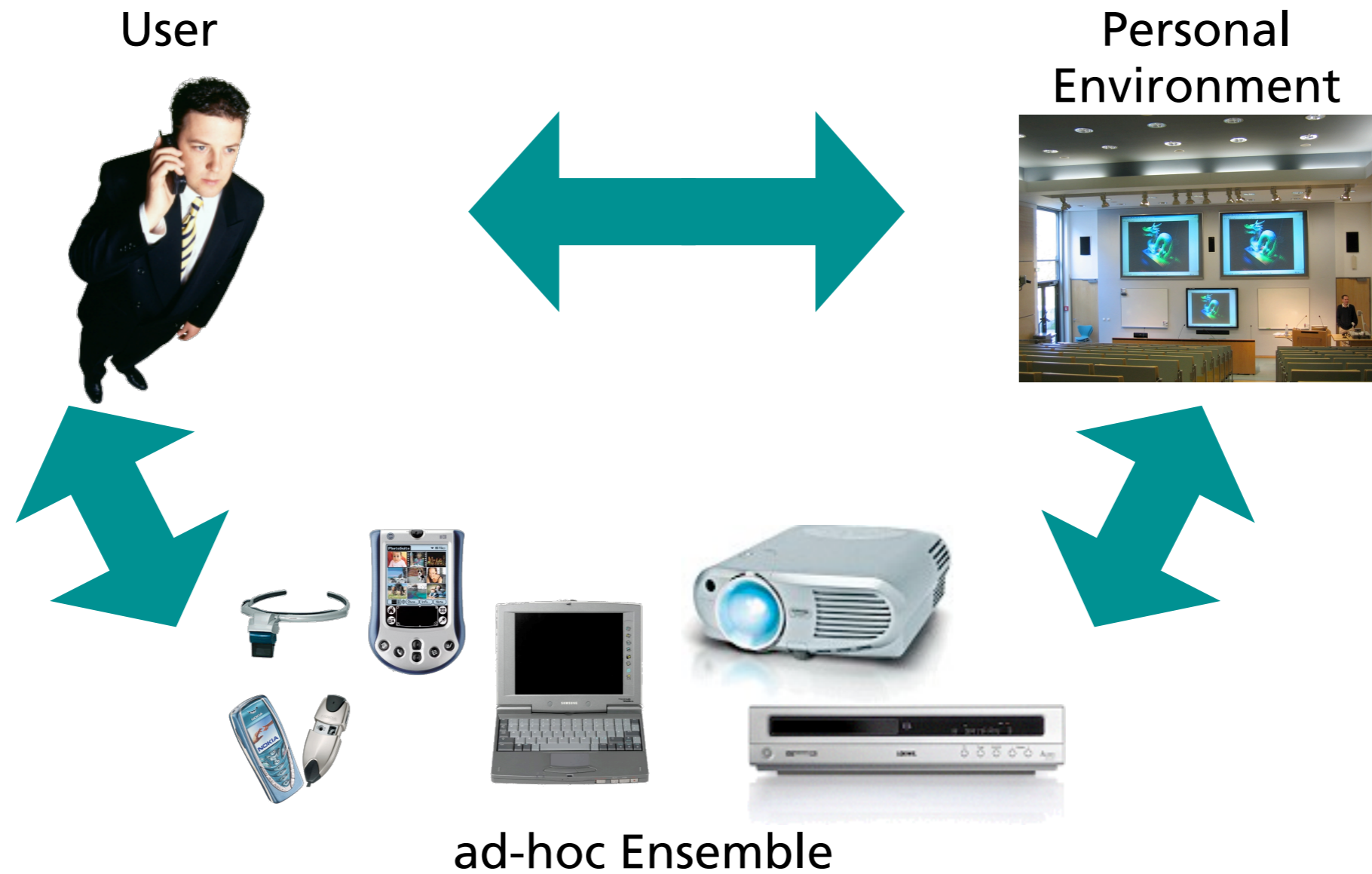
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# Smart Environments - ad-hoc Ensembles

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# Strategy Source?

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## ■ Ubicomp Visions:

- Invisible Computer
- Dynamic Ensemble

## ■ Can't learn Strategy from User!

- If devices are invisible, they cannot be part of a strategy.

## ■ Can't learn Strategy from the System Designer!

- Designer can't anticipate features of dynamic added devices.

## ■ So: Strategies have to be generated dynamically by the ensemble.



# Goal-based Interaction

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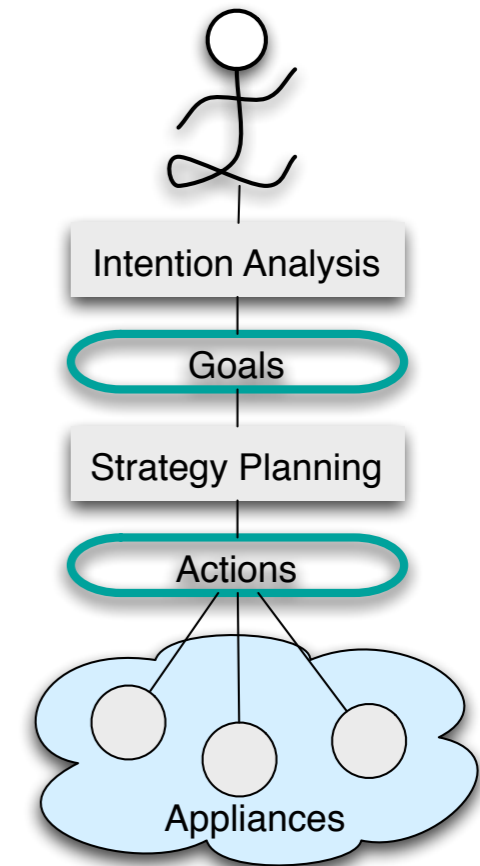
## ■ Two kinds of goals:

## ■ Goals as Environment-State

- Sequential Planning of Strategies

## ■ Goals as Definition of optimal Ensemble Behavior

- Resource Optimization / Scheduling



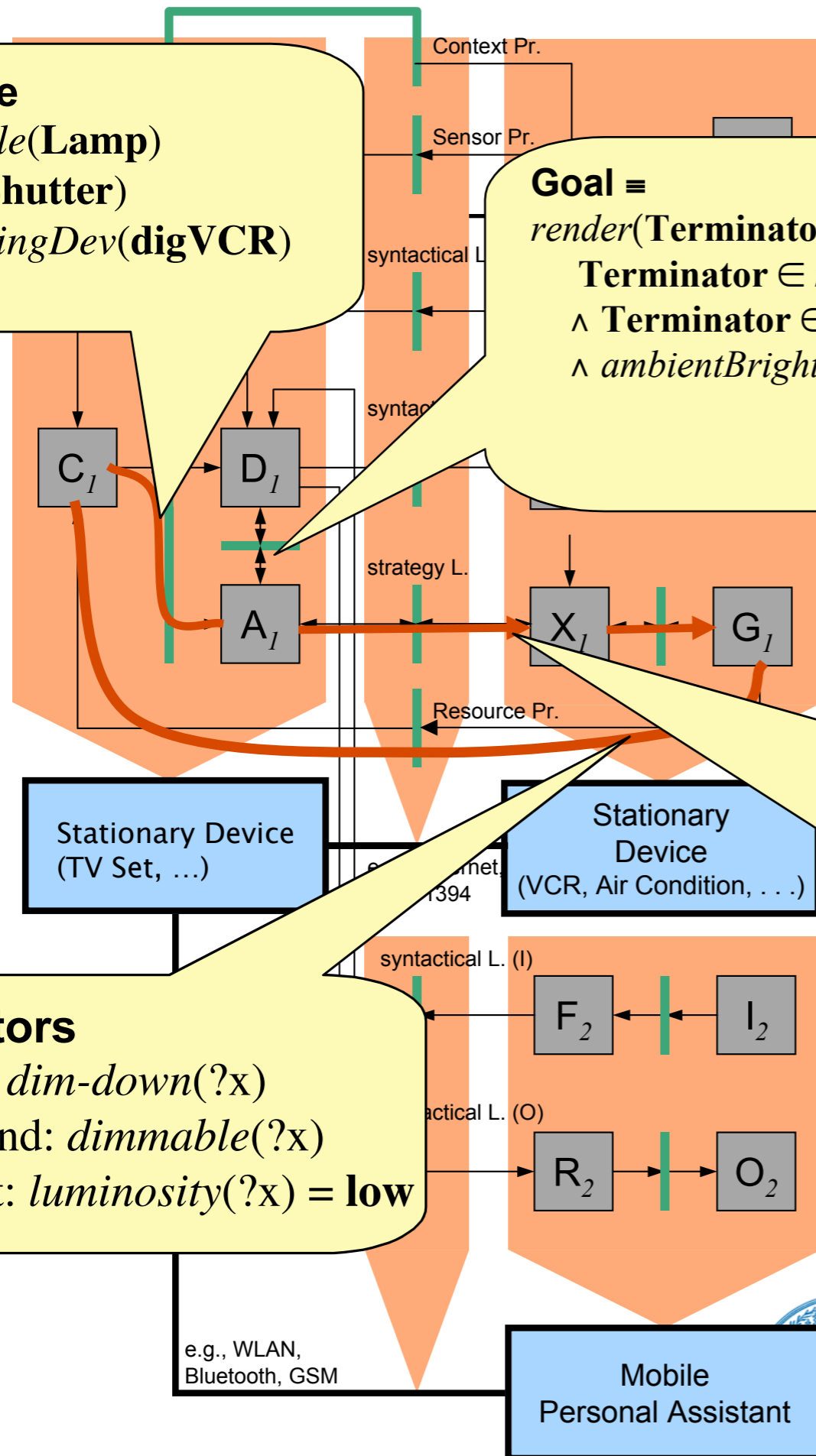
# Sequential Strategy Planning

**Init state**  
*(dimnable(Lamp)*  
 $\wedge$  *open(Shutter)*  
 $\wedge$  *renderingDev(digVCR)*  
 ...)

**Goal  $\equiv$**   
*render(Terminator) =*  
**Terminator**  $\in$  *renderedMedia*  
 $\wedge$  **Terminator**  $\in$  *perceivableMedia*  
 $\wedge$  *ambientBrightness = low*

**Plan  $\equiv$**   
 { #1  $\rightarrow$  (**digVCR.play(Terminator)**, {#2,#5,#8})  
 #2  $\rightarrow$  (**Shutter.close**, {#3})  
 #3  $\rightarrow$  (**Lamp.dim**,  $\emptyset$ )  
 #4  $\rightarrow$  (**TV.turnOn**,  $\emptyset$ )  
 #5  $\rightarrow$  (**TV.switchInput(digVCR)**, {#4})  
 #6  $\rightarrow$  (**Amp.turnOn**,  $\emptyset$ ),  
 #7  $\rightarrow$  (**Amp.switchInput(digVCR)**, {#6})  
 #8  $\rightarrow$  (**Amp.setVolume(medium)**, {#7})

**Operators**  
 Action: *dim-down(?x)*  
 Precond: *dimnable(?x)*  
 Effect: *luminosity(?x) = low*





# Resource Optimization

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- Reactive Environment Simulation System (RESy)
- Theory of optimal utilization of multiple displays
  - Document - Display Mapping on basis of *Visibility / Projectability* and *Importance*



# Theory of optimal ensemble behavior

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Visibility  $v : Surface \times User \rightarrow [0; 1]$ , z. B. vereinfacht als:

$$v(s, u) = \max \left\{ 0, \frac{\langle \vec{n}_s, \vec{u} - \vec{s} \rangle}{\|\vec{u} - \vec{s}\|} \right\}$$

Projectability  $p : Display \times Surface \rightarrow [0; 1]$

Importance  $i : Document \times User \rightarrow [0; 1]$

Display Maps:  $YM = Display \rightarrow Surface$

Document Maps:  $DM = Document \rightarrow \mathbb{P}Display$

$$q_{\max} = \max_{\substack{ym \in YM \\ dm \in DM}} \left( \sum_{\substack{u \in User \\ d \in Document}} i(d, u) * \max_{y \in dm} v(ym y, u) * p(y, ym y) \right) / \left( \sum_{\substack{u \in User \\ d \in Document}} i(d, u) \right)$$



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- Look at the poster!
- Thank you!

