

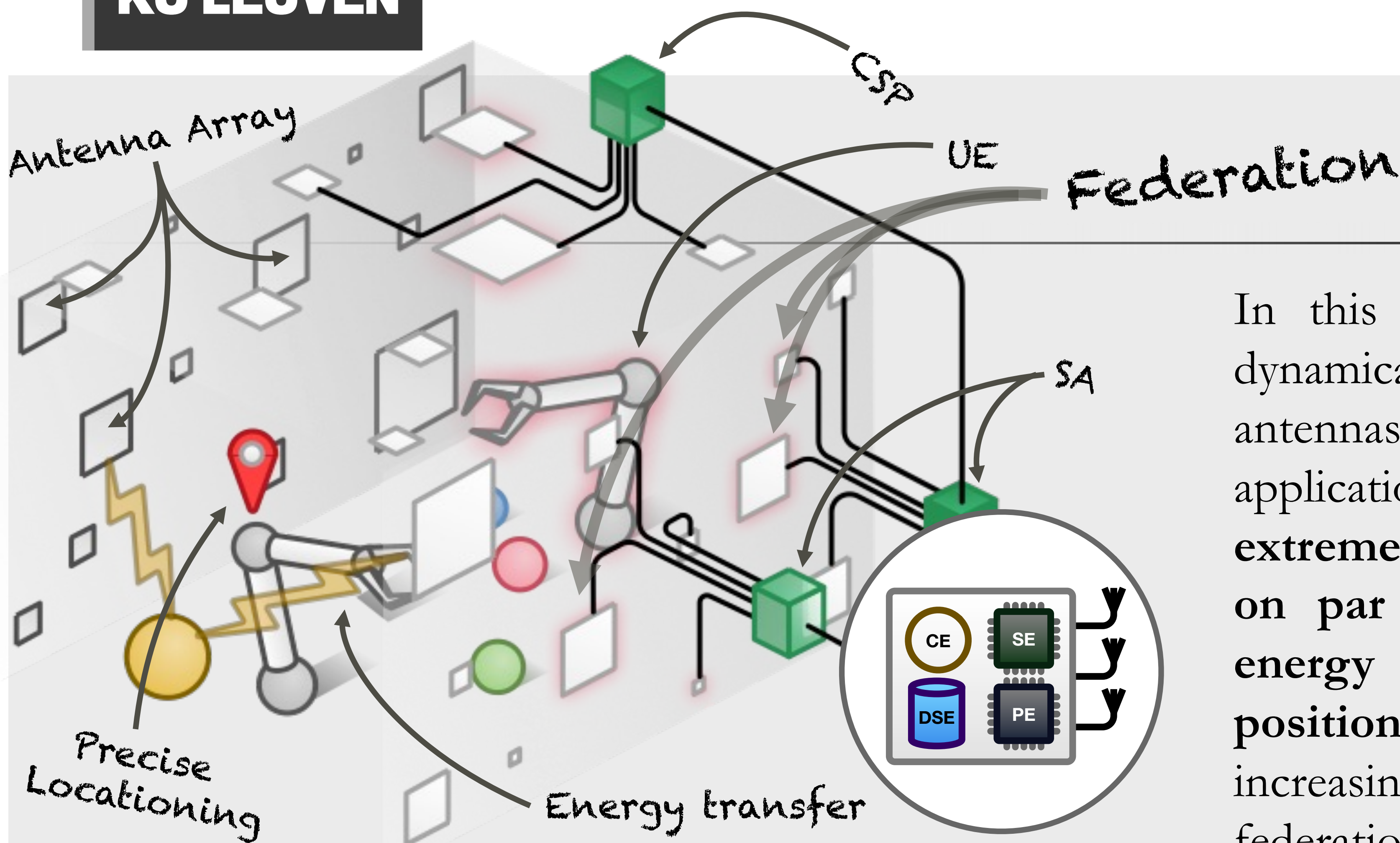


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# Dynamic Federations for 6G Cell-Free Networking: Concepts and Terminology

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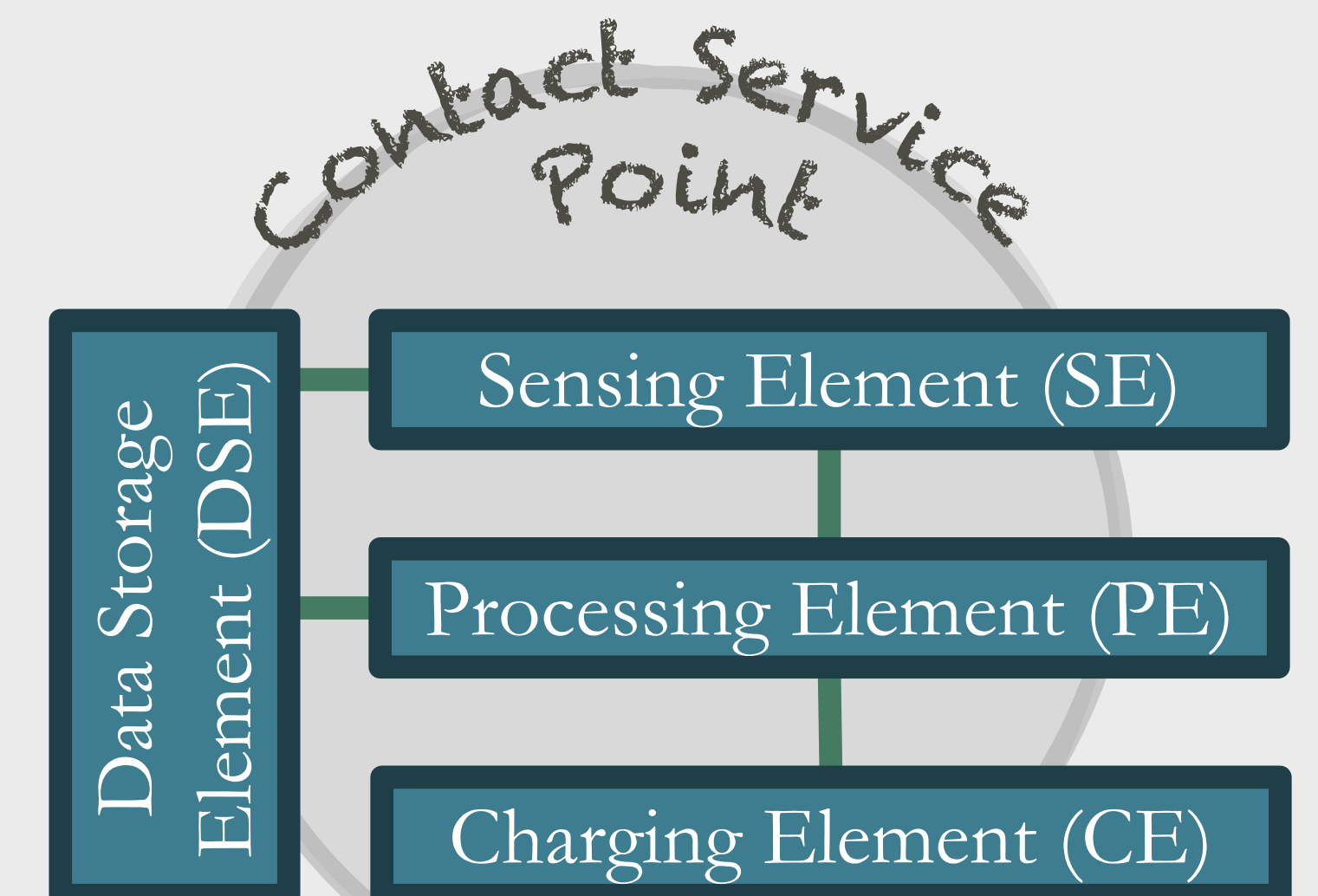
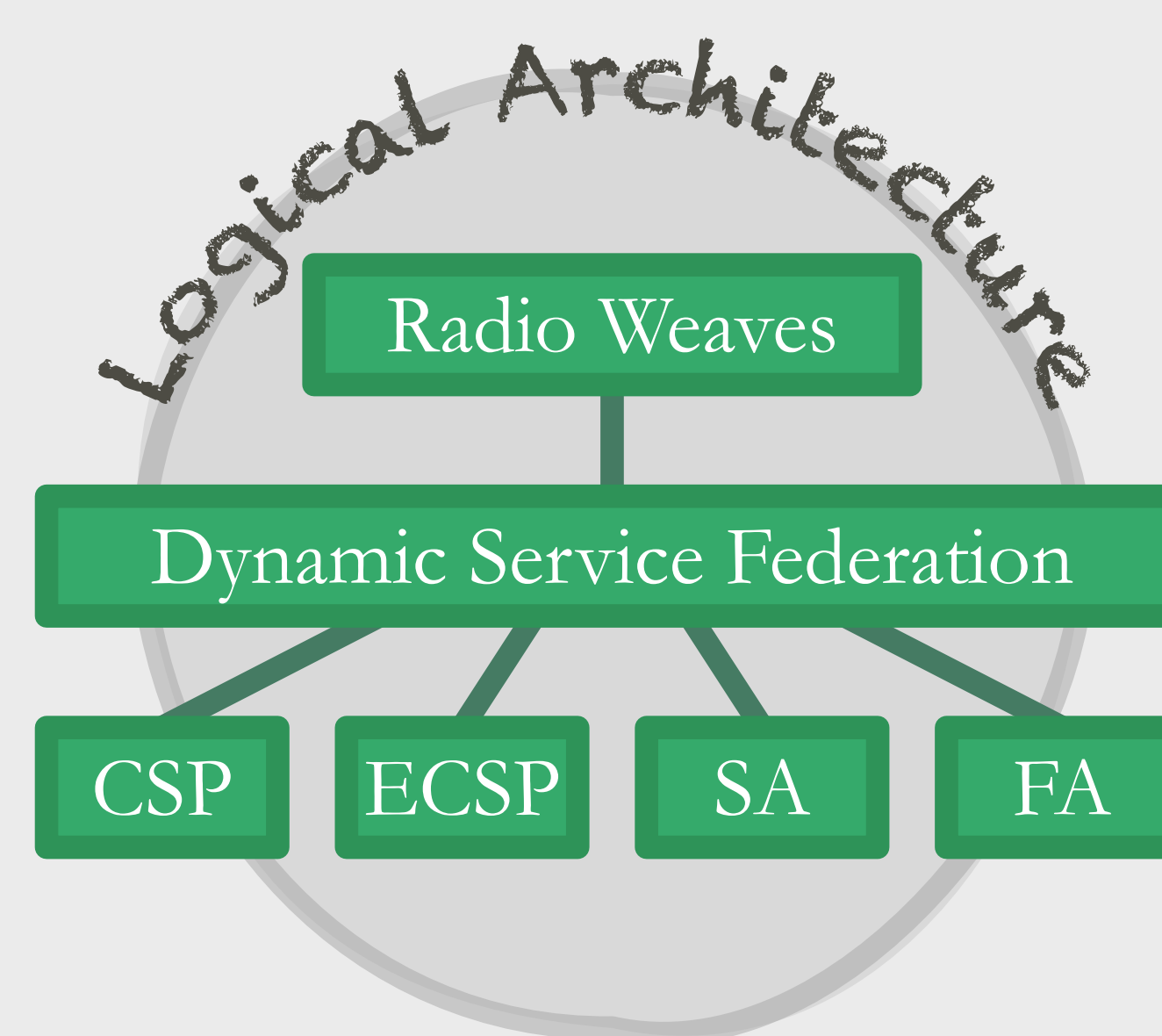


## 6G and RadioWeaves

In this work, we introduce the concept of federations to dynamically scale and select the best set of resources, e.g., antennas, computing and data resources, to serve a given application. 6G systems are expected to provide services such as **extreme data rates, imperceptibly low latency, dependability on par with wired networks, low-power usage, wireless energy transfer** for energy neutral devices, and **precise positioning**, to a massive number of low power devices. Further increasing the complexity of such systems. Therefore, each federation is self-managing and is distributed over the area in a cell-free manner. *RadioWeaves* is an architecture that implements these services and is based on Large Intelligent Surfaces (LIS).

## System Architecture

A large set of active antennas are densely distributed throughout a three-dimensional space. Where in Cell-Free the antennas are geographically distributed, in LIS large panels of resources are encapsulating the users. The antennas are managed in a distributed and cell-free manner, i.e., all resources in the network can be used to provide a given service.



## What are dynamic federations?

Dynamic federations consist of constellations of antennas, edge computing units, data storage, and other resources, to serve a specific application class. We distinguish **logical entities** and **physical elements**. Physical element, are infrastructure hardware elements that supports, e.g., wireless charging. These hardware resources can be logically mapped to entities to form the RW infrastructure and contact points for the users.

Dynamic federation terminology

Name	Abbr.	Description
Contact service point	CSP	UE's first contact point. Integrates computing, storage, and communication.
Edge computing service point	ECSP	Shared compute resources for applications and backhaul.
Synchronization anchor	SA	A synchronization reference for a set of cooperating CSPs.
Federation anchor	FA	Responsible to orchestrate and to coordinate a federation, likely in an ECSP.
Sensing Element	SE	Unit in CSP for sensing environment, e.g., radio channels or cameras.
Data Storage Element	DSE	Memory resource integrated in a CSP.
Processing Element	PE	Local computational resources integrated in a CSP.
Charging Element	CE	Charge devices in the environment.
Radio Element	RE	Transmit/receive units, most often including an antenna.

## A smart factory example

The figure to the right shows an example deployment of *RadioWeaves* in a smart factory, with four federations, and four applications. **AR** for professional applications (purple), tracking of robots and **UVs** (green), **tracking of goods** and real-time inventory (blue), and human-robot **co-working** (red). Each application is served by a federation, with its CSPs shown in the same colour as the application. The above applications collectively require, extremely high data rates, up to 3 Gbps, imperceptibly low latency, wireless power transfer, and very high positing accuracy.

