INTRODUCING THE NEW GENERATION OF NAO ROBOT

NAO⁶

Outline

NAO⁶ INTRODUCTION

- NAO⁶ INTRODUCTION
- NAO⁶ IMPROVEMENTS
- MARKET SECTORS
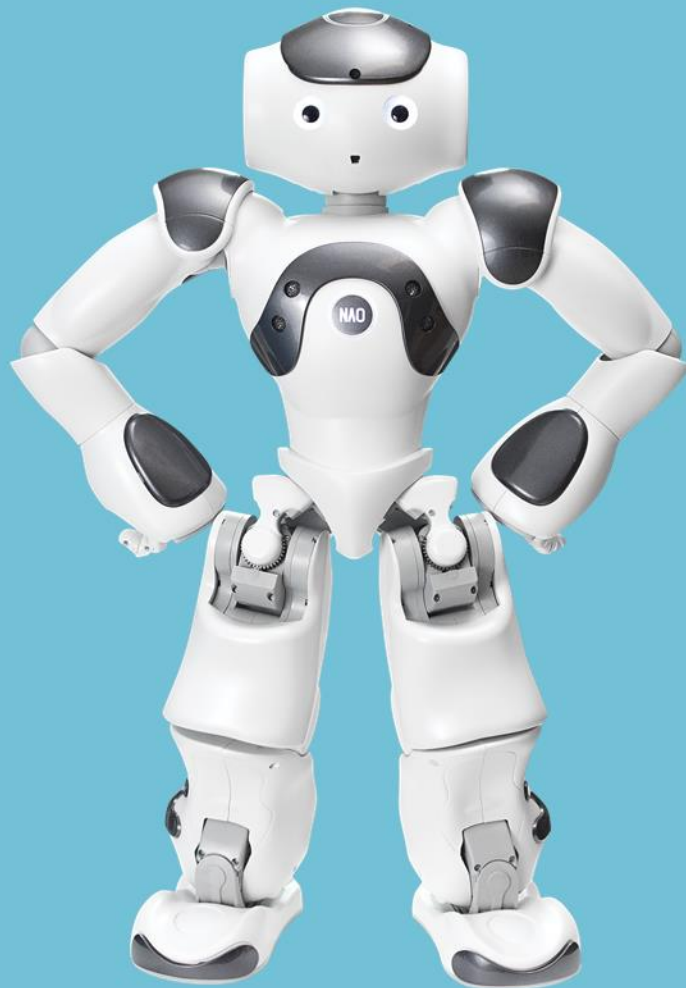
THE 6TH GENERATION OF HUMANOID ROBOT NAO

II Attractive programmable platform: create a unique human-robot interaction experience and leverage it to a new level **II**

SoftBank Robotics

DETECTION
2 5-megapixels cameras

ACOUSTIC
4 omnidirectional microphones
2 loudspeakers

COMPUTING
CPU ATOM E3845
Quad core 1.91 GHz
4 GB DDR3 RAM
32 GB SSD

CONNECTIVITY
Bluetooth – Ethernet - Wi-Fi

GRACEFUL BODY MOVEMENTS
25 degrees of freedom

ADAPTIVE WALK
8x Force Sensitive Resistors

EXPLORATION
4 sonars to detect obstacles

58 cm

5,5 kg
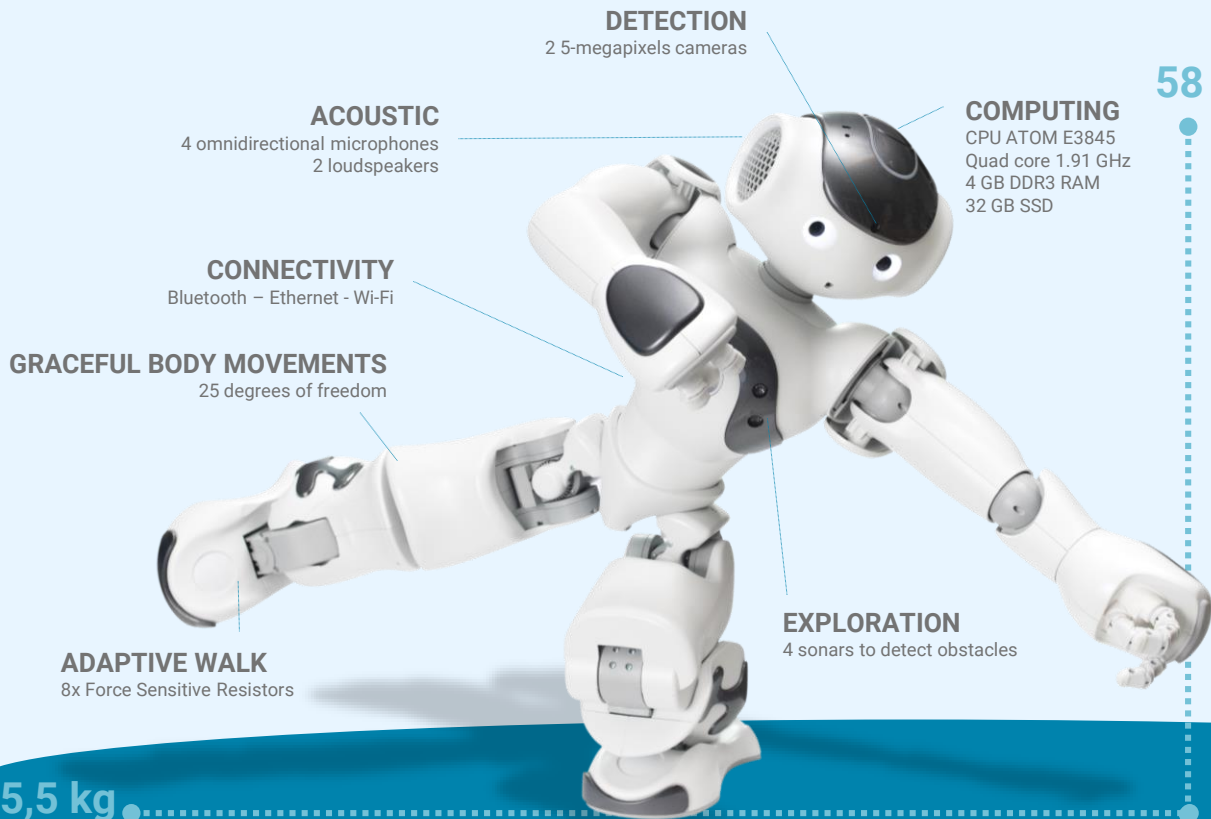
NAO ^{6}

SPEECH RECOGNITION
More than 20 Languages

FALL MANAGER
Detects falls & trigger the protection

FALL RECOVERY
Able to stand up alone

NAO^6, 6 MAJOR AREAS OF HARDWARE IMPROVEMENT

II A continuous augmentation of robot performance: enriched package for a greater product **II**

SoftBank Robotics

1 - POWER
CPU – ATOM Z530 ➜ E3845
Memory: 8GB SDCard ➜ 32GB SSD

2 - VISION
Camera – Aptina MT114 1.3Mpix ➜
Omnivision 5640 5Mpix

3 – AUDIO
Cardioid mic ➜
Omnidirectional mic
+ Audio codec

4 – MOTION
Motors - PortEscape 16 GT ➜
PortEscape 16 GT MP

5 – ROBUSTNESS
Finger - Robustness Improvement

6 – CONNECTIVITY
Bluetooth
New Wi-Fi
Better Ethernet
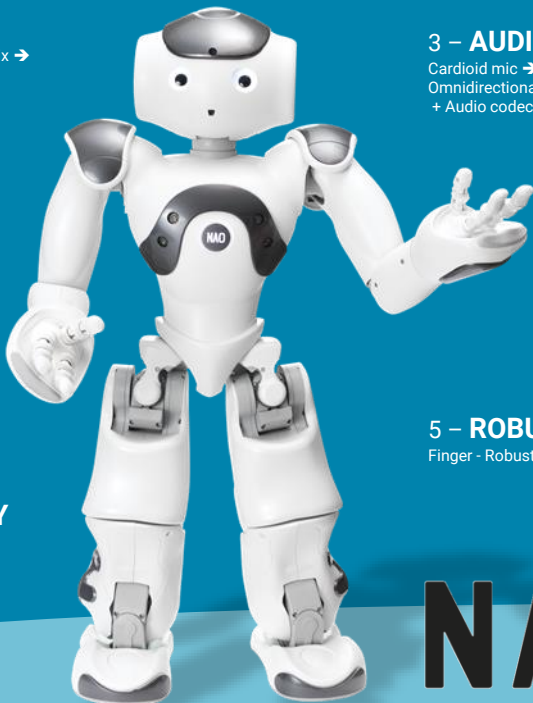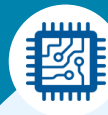
NAO^6

1 - POWER
NAO^6 benefits from the progress made on Pepper which makes it more powerful.

2 - VISION
With its new cameras, NAO^6 better detects people.
Dual stream of the top and bottom cameras is now supported.

3 - AUDIO
NAO^6 hears and understands a lot better making dialog a full part of the interactions.

4 - MOTION
Thanks to its new motors, NAO^6 can move longer without overheating.

5 - ROBUSTNESS
NAO^6 benefits from many robustness improvements on motors and fingers providing an extended lifetime.

6 - CONNECTIVITY
NAO^6 is more connected than ever with Bluetooth and a more efficient and faster Wi-Fi.

NOTE: See Annex for more detailed comparison with NAO Evolution

OUR OFFER

II We bring value **in each step of your application development II**

SoftBank Robotics Support

NAO⁶ Application development

Plan → Analysis → Design/Develop → Implement → Test/Integrate → Maintain
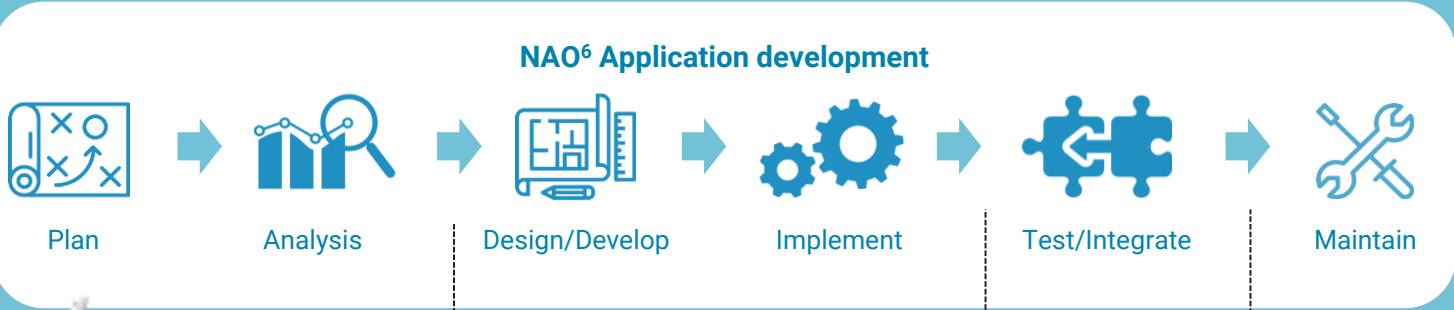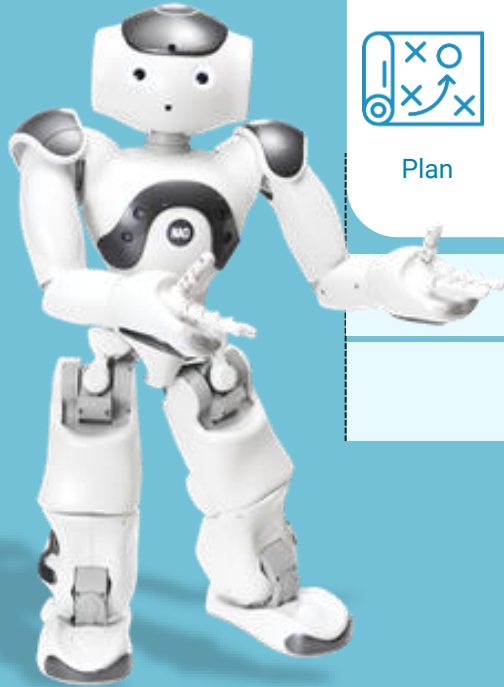
Consult & Support

Trainings & Tutorials
Documentations

Choregraphe (App development tool)
NAOqi (Robot operational system) APIs & SDK
ADE (Robot App mgmt. store)

Monitor (Robot feedback tool)
Customer service

NOTE: See Annex for more detailed Software and Tools improvement

NAO[6] CAN BE USED IN VARIOUS SECTORS

II An **innovative and advanced interface of** communication, interaction and education **II**

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EDUCATION

👤 **Any type of school** from kindergarten to University

Coding & programing

Literature & learning

Special education

Laboratory & Research

HEALTHCARE

👤 Adapted solution for **caregiver and patient,** for any type of facility

Hospital

Nursing home

Specialized facility

Pharmacy

CUSTOMER FACING ENVIRONMENT

👤 Any **physical places** for innovative assistance & dynamic communication

Retail

Travel & Hospitality

Bank & Assurance

Company & coworking space

Public service

NAO⁶ VALUE PROPOSITION & BENEFITS

- NAO⁶ VALUE PROPOSITION
- NAO⁶ USE CASE
- NAO⁶ BENEFITS

VALUE PROPOSITION FOR <u>EDUCATION</u>

II Educational robot: Improve knowledge dissemination, augment student engagement & broaden window for future talents **II**

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OPTIMIZED TEACHING-AID TOOL

- New & innovative **pedagogical topics** - sharpen **concentration & focus**
- **Tailored and flexible** teaching programs - motivate **STEM** subjects & **encourage creativity** (eg: Open Roberta)
- Enable remoted education - **virtual presence & distance learning**

ADVANCED DEVELOPMENT PLATFORM

- **Innovative platform** allows development from simple concepts to complex algorithms
- **Visual & intuitive** programming interface
- **Problem solving & analytical skills** development

EFFICIENT SOLUTION TO INCLUSIVE EDUCATION

- **Promote inclusivity** – engage special education *e.g. autism** & students with disabilities
- **Barrier-free communication** *(Reduce shyness, reluctance, confidence and frustration*)*
- Various **ready-to-use applications** are available by our partners – **accessible & upgradable**

NAO robot has been selected to be the standard platform for RoboCup Soccer.

Source: ResearchGate; The tech edvocate;

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HEALTHCARE ADVOCACY

- Ambassador to **arise public awareness** on prevention care
- **Unique and optimized patient experience** for better engagement
- Interactive & intellectual interface for **patient adherence** enhancement

INTERGRATED CARE CONTRIBUTOR

- Integrated & connected solution to **expand more value-based care**
- Remote-monitoring capabilities to **expand reach of care-giving**
- A **learning & training** tool to develop patient's **functional ability & intrinsic capacity**

INVESTMENT VALORIZATION: RAAS (Robot As A Service)

- The differentiator – **a distinctive & attractive digital offer**
- Scalable platform to **expand** business with other **value-chain players**
- Service-orientated models to **realise monetisation of value**

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SINGLE VIEW OF CUSTOMER

- A **powerful touch point** to omnichannel;
- A single but comprehensive **view of each individual customer**

MARKETING & ENGAGEMENT

- Interact with customers using **relevant messages & offers**
- Treated them **specially, personally** and **individually**

COMMERCE & SERVICES

- **Guide and assist** the customers to **sell the product** or **improve awareness** by **providing services**, based on their **needs & requirements**

NAO⁶ ASSISTS IN DIFFERENT MISSIONS

II Flexible & multi-functional - Easily & accurately switch to another mission with effectiveness **II**

Education

- Knowledge distributor
- Programming tool

Healthcare

- Coach / Trainer
- Communicator

Consumer facing environment

- Sales associate

Education & Healthcare

- Assistant

Education, Healthcare & Consumer facing environment

- Receptionist
- Brand ambassador
- Advisor
- Service provider
- Survey conductor
- Entertainer

HOW NAO[6] DOES IT DIFFERENTLY?

II Competence & Abilities: provide a worth-to-share and worth-to-repeat experience **II**

PROACTIVE ENGAGMENT

Detect & attract people with *animated expression*

MULTI LANGUAGE

Easily speak & switch languages

INFORMATION PRESENTATION

Accurately deliver brands, products & service information

REALTIME COMMUNICATION

Update speech & deliver messages with *real-time data*

COGNITIVE COMPUTING

Capture *demographic data & emotions* of the user

CUSTOMISED INTERACTION

Adapt the *interaction content* based on user profile

PRODUCT RECOMMENDATION

Introduce *relevant* products & services based on *preference*

IDENTITY RECOGNITION

Identify people via code-scanning, Booking #, faces, etc....

SERVICE OFFERING

Provide *added-value* service & realize *upselling, cross-selling*

DATA COLLECTION

Collect *info*, generate *leads & insights*, *learn* from data

IN-GAME ADVERTISING

Advertise brands & services via interactive robot games

ENTERTAINMENT

Entertain people with the *'worth-to-share NAO[6] experience'*

NAO[6] ADDED VALUE & BENEFITS

II A new channel to transform user experience & achieve cross-functional needs **II**

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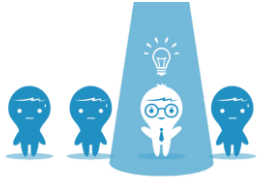
Stand out & Raise **awareness**

Improve UX & attract undivided **attention**

Enhance **stakeholder relationship**

Cost-Effectiveness & higher **efficiency**

Relieve workload & **unlock** people's **potential** for more valuable tasks

Collect **comprehensive data** to generate **valuable insight**

Bring **beneficial add-ons** & inspire **creativities**

SOFTBANK ROBOTICS

- LEADER OF HUMANOID ROBOT'S MARKET
- WHY HUMANOID ROBOT?
- REFERENCES

SOFTBANK ROBOTICS, THE LEADER IN HUMANOID ROBOTS' MARKET

ǁ 13 years of **expertise,** we continuously improve **our know-how**... **ǁ**

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Robotics

TO DATE, **WORLDWIDE**:

+25,000 Pepper & Nao robots deployed

+500 Employees

+150 partners in our ecosystem

Shareholders: SoftBank Alibaba Group 阿里巴巴集团 FOXCONN

WHY HUMANOID ROBOT?

|| We make best-in-class robots to **meet the highest human acceptance ||**

Uncanny valley – A hypothesized relationship between the degree of an object's **resemblance to a human being** and **the emotional response** to it.

Uncanny valley

Humanoid robot

Stuffed animal

Industrial robot

Marionette

Healthy person

Zombie

Too-Realistic Humanoid robot

Human Likeness

Familiarity
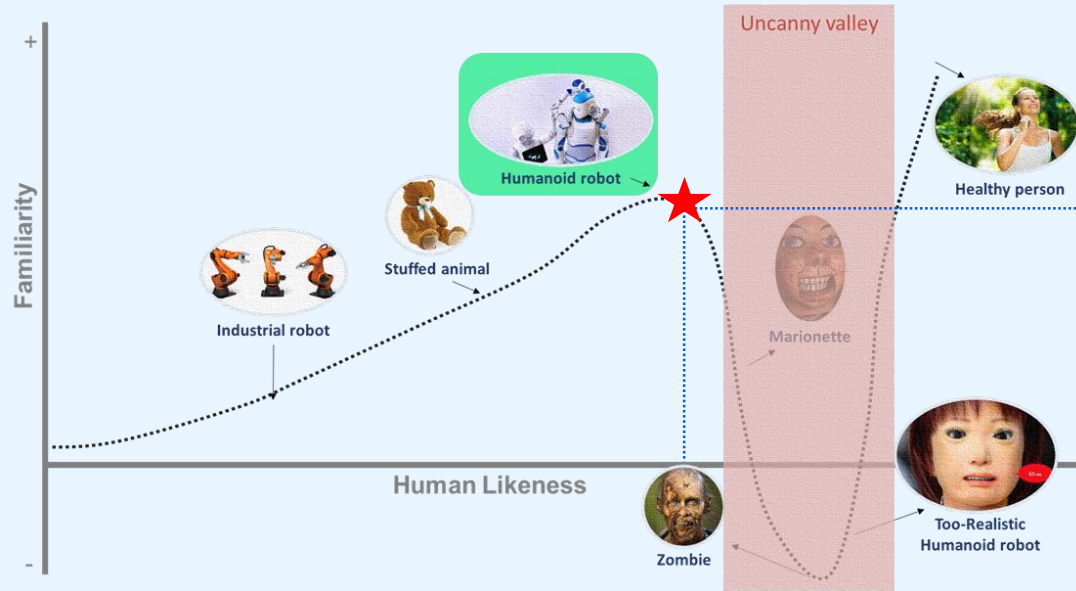
Before reaching this point, the objects became more human-like, people would find them to be **more acceptable and appealing than** their **mechanical counterparts**.

When human-likeness increases below this point, when they are close to, but not quite, human, people **develop a sense of unease and discomfort** until it close to a real health human beings.

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ATTRACTIVE APPEARANCE

- Designed without ambiguity, the eye-catching outlook attracts **undivided attention**

NATURAL BODY LANGUAGE

- Fluid and expressive body language together with voice & visual images, which **enhance the communication**

EMOTIONAL EMPATHY

- Build an **empathic & emotional** relationship between human & robot
- Adapted robot behavior & perfect ergonomic size ➜ **Embraced-by-all**

PROACTIVE ENGAGEMENT

- Being perceived as '**no danger**', '**no judgement**' & '**in-control**'
- Proactively engage in **icebreaking conversations**

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CONNECTIVITY

- Assemble **disconnected services**
- Collect **comprehensive** data
- **Integrate** other solutions which **expand its capacities**

MULTI-FUNCTIONALITIES

- Contain multi-functional components, sensors which **enable & augment AI technologies**

MAIN HARDWARE IMPROVEMENTS
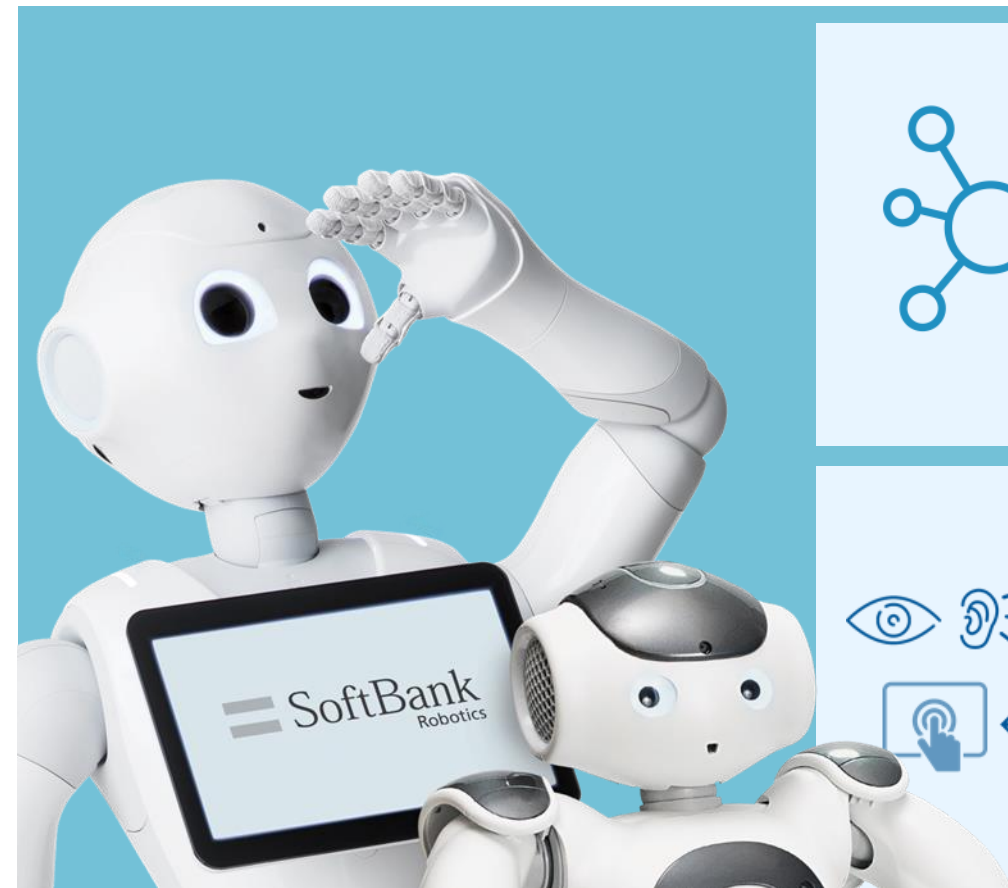
NAO

NAO⁶

Motherboard

- ATOM Z530 **1.6 GHz**
- CPU **Bi core**
- **1 GB** RAM
- **2 GB** Flash memory + 8 GB Micro SDHC

- ATOM E3845 **1.91 GHz**
- CPU **Quad core**
- **4 GB** DDR3 RAM
- **32 GB** SSD

Camera

- Field of view : 72.6°DFOV (60.9°HFOV,47.6°VFOV)
- Focus range: 30cm ~ infinity
- Focus type : **Fixed focus**

- Field of view : **68.2**°DFOV (57.2°HFOV,44.3°VFOV)
- Focus range : 30cm ~ infinity
- Focus type : **Autofocus**

Audio

- Cardioid microphones (-12dB)
- Loudspeakers: Foxconn Amato

- Omnidirectional microphones (-12dB) + Audio codec
- Loudspeakers: Seltech 40S19 custom

Motor

- New motors with a lifetime improvement

Color

- Red, blue, light grey

- Dark grey

NAO6 vs. NAO Evolution (1/2)

	NAO	NAO⁶	NAO⁶ Performance *
Boot time	131.7 s	51 s	~3x faster
System upgrade time	22' min	4'24'' min	~5x faster
Ethernet performance	Download 162 Mbit/s Upload 138 Mbit/s	Download 657.54 Mbit/s Upload 652.01 Mbit/s	~4x faster ~4x faster
Wi-Fi performance	Download 13 Mbit/s Upload 15.5 Mbit/s	Download 124.45 Mbit/s Upload 83.90 Mbit/s	~10x faster ~5x faster
Disk memory	Read speed 4.6 MB/s Write speed 1.9 MB/s Effective user dedicated space 15 GB	Read speed 73 MB/s Write speed 67 MB/s Effective user dedicated space 23 GB	~16x faster ~35x faster ~2x better
CPU	Effective user dedicated CPU 33%	Effective user dedicated CPU 58%	~2x more effective
RAM	Effective user dedicated RAM 600 MB	Effective user dedicated RAM 2.8 GB	~5x more effective

* May 2018 tests results - Confidential

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	NAO	NAO[6]	NAO[6] Performance *
Fan Noise @ 1m (100% / 60%)	40,7 dB(a) / 38,8 dB(a)	50 dB(a) / 36 dB(a)	**Better cooling performance**
Worst case CPU temp (fan 100%)	84°C	74°C	**Better cooling performance**
WER in quiet environment : → *ambient 50dB / voice 70dB*	90%	10%	**~9x understanding**
WER in public environment : → *ambient 73dB / voice 76dB*	80%	30%	**~2.5x understanding**
Speaker volume	80dB(c)	89dB(c)	**~2x louder**
Microphone saturation (from speakers in %)	N/A	74 %	**Allow Acoustic Echo Cancellation**
Camera resolution	Top : 1280 x 960 @ 5fps Bottom : 1280 x 960 @ 5fps	Top : 2560x1920 @15fps Bottom : 1280x960 @ 15fps	**~2x on Top camera / similar on bottom**
Dual Mode Camera	Not stable	Yes	**⇒ New feature**
Camera Auto-focus	Not available	Yes	**⇒ New feature**

* May 2018 tests results - Confidential

OPEN AND DEDICATED SOFTWARE & RESOURCES

‖ A programmable robotic platform: easy-to-code & backed up with SBR expertise' support **‖**

SoftBank Robotics

Cloud Services

External API, database & IT system integration

AWS ... Microsoft Azure ...

NAOqi APIs

More than 140 services for +1000 available functions

Existing APIs at both **low & high level** allow APP to **control robot behavior**

Sensor reading, motor piloting, listening, speaking, detecting, ...

Call external services

Call embedded services

Additional robot features:

Autonomous ability
Breathing mimic
Head tracking
Animated speech with body expressions

Self-diagnosis & protection
Constantly checking all components
Reporting errors
Switching to protection mode automatically

Upload to ADE *(Robot App mgmt. store)*

Upload directly to robot

1

Pack Apps

Desktop features

Choregraphe
- *C++, Python, Java, etc...*

Monitor
- *Elementary feedback from robot*
- *Access to camera settings*
- *Memory backup*

Robot settings
- *Getting started wizard*
- *Configure robot from desktop*

Qi **OS**

NAOqi

2

Send command & Info

3

OPEN AND DEDICATED SOFTWARE & RESOURCES
‖ Improvements & New features ‖

SoftBank Robotics

Cloud Services

AWS, Microsoft Azure, ...

NAOqi API & SDKs 2.8

Former **DCM** replaced by new version **(LoLA)**
Motion
- *More reliable sensor feedback*
- *NAO^6 Kinematic model*
- *New diagnosis reflexes*

OpenCV 3 for better vision performance,
And more...

Other improvements:

SSH

QiCli Info
See information on robot
Use methods

Cloud trusted platform module
Improve the communication security

1

Desktop features
Choregrahe 2.8
- *OSX support improved*

**Robot settings – new tool
(replace the webpage)**

Qi OS
**Updated &
New package**

2

3