ambient
INTELLIGENCE

Künftige technologische Möglichkeiten zur Unterstützung des häuslichen Umfeldes

„Technologie-/Hardware Sicht"
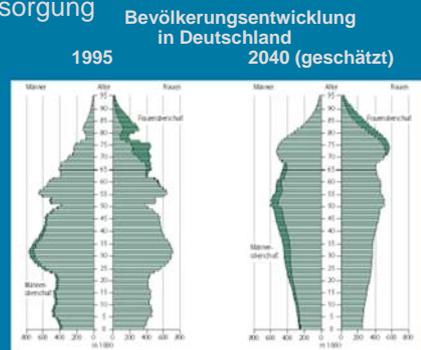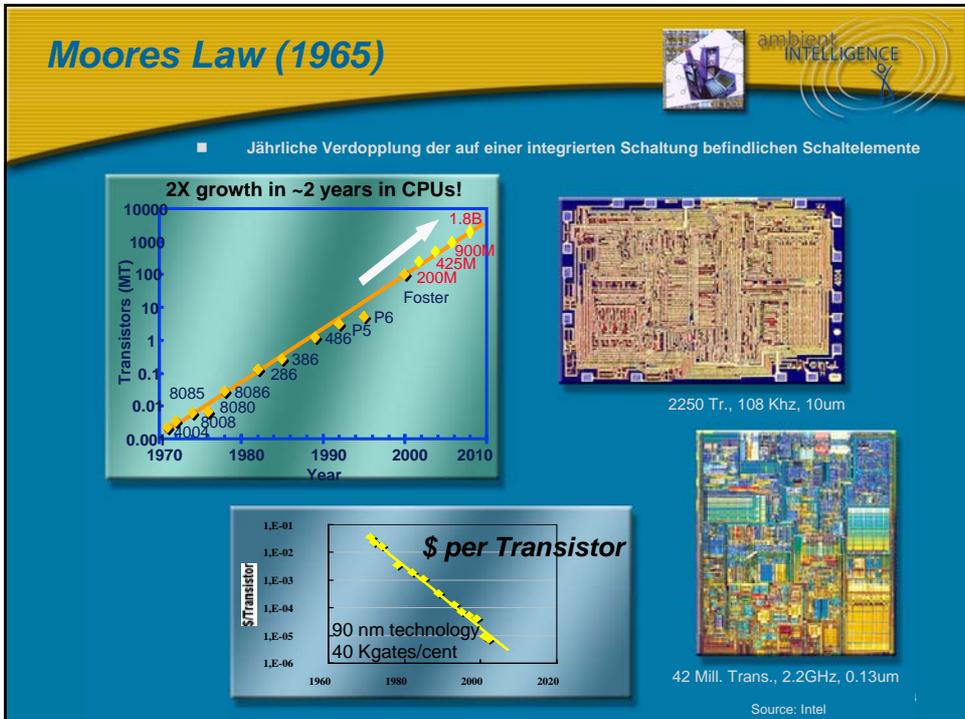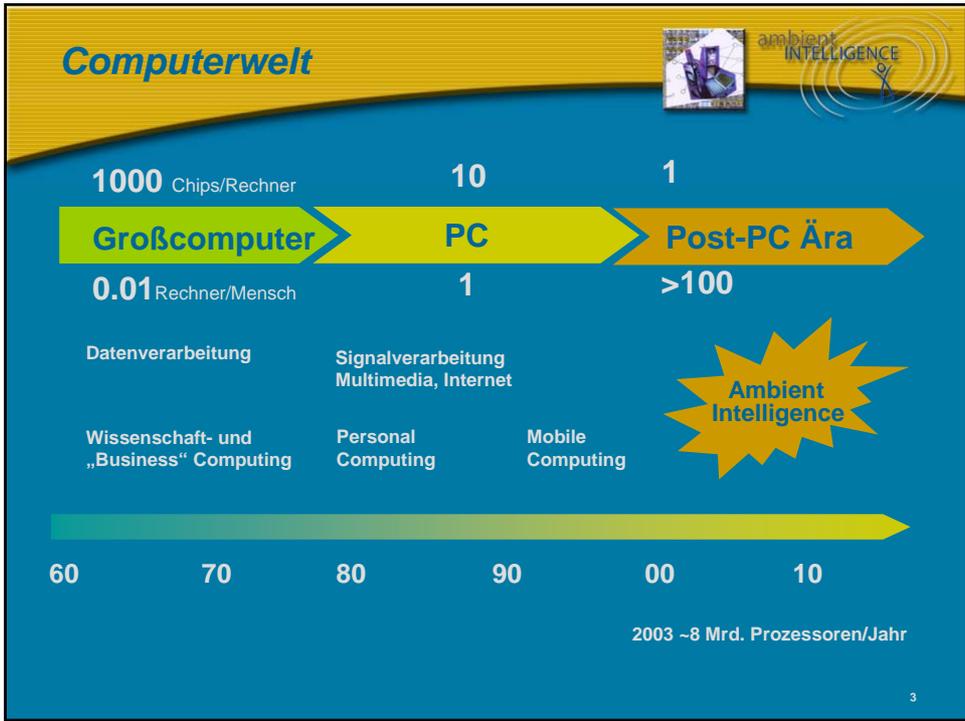
Norbert Wehn

Situation Gesundheitswesen

ambient
INTELLIGENCE

- **1997**
  - ➔ 10.5% BIP
  - ➔ 11.2% der Berufstätigen
- **Prognose 2013 bei deutlicher Verschiebung der Altersstruktur**
  - ➔ 12% BIP in medizinischer Versorgung
  - ➔ 13% der Berufstätigen
- **Krankenhausbetten – 20 %**
- **Häusliche Pflege + 40%**

- **nur erreichbar durch massiven Einsatz von Informationstechnik und vernetzten eingebetteten Systemen**

  Quelle: Gesundheitsversorgung in der
  Informationsgesellschaft,
  eine Prognose für das Jahr 2013.
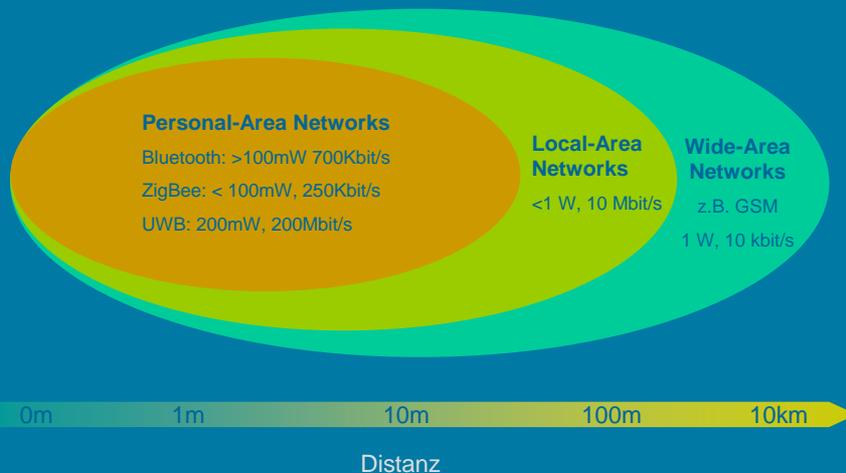 Haux et al., 2003, VAS

Bevölkerungsentwicklung in Deutschland

1995   **2040 (geschätzt)**

2

Computerwelt

1000 Chips/Rechner	10	1
Großcomputer	**PC**	**Post-PC Ära**
0.01 Rechner/Mensch	1	>100

Datenverarbeitung

Signalverarbeitung
Multimedia, Internet

Ambient Intelligence

Wissenschaft- und „Business" Computing

Personal Computing

Mobile Computing

60	70	80	90	00	10

2003 ~8 Mrd. Prozessoren/Jahr

3

Moores Law (1965)

■ Jährliche Verdopplung der auf einer integrierten Schaltung befindlichen Schaltelemente

2X growth in ~2 years in CPUs!

Transistors (MT)

1.8B
900M
425M
200M
Foster
P6
P5
486
386
286
8085 8086
8080
8008
4004

| 1970 | 1980 | 1990 | 2000 | 2010 |
Year

2250 Tr., 108 Khz, 10um

$ per Transistor

90 nm technology
40 Kgates/cent

42 Mill. Trans., 2.2GHz, 0.13um

Source: Intel

2

Kommunikationstechnik

- **Beispiel Mobilfunk (Deutschland)**
  - → C-Netz (1985) : 0.8 Mio. Teilnehmer
  - → GSM (2005) : >60 Mio. Teilnehmer (1 Milliarde weltweit)

Size: 210 x 168 x 80 mm
Weight: 2500 g
Transmit Power: 5 W

GSM Phone (Siemens) from 1991

	2. Generation	3. Generation
Datenraten	→ 9.6 kbps	→ 2 Mbps
Anwendungen	→ Sprache → SMS	→ Multimedia → Interaktivität
Standards	→ GSM → CDMA (IS 95A) → PDC	→ UMTS → CDMA 2000
Produkte	→ Handys	→ Multimedia → Laptops

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Drahtlose Netzwerke

Personal-Area Networks

Bluetooth: >100mW 700Kbit/s

ZigBee: < 100mW, 250Kbit/s

UWB: 200mW, 200Mbit/s

Local-Area Networks

<1 W, 10 Mbit/s

Wide-Area Networks

z.B. GSM

1 W, 10 kbit/s

0m   1m   10m   100m   10km

Distanz

6

„Smarte" Materialien

- **Polymer Halbleiter**
  - ➔ druckbare Elektronik
- **Licht emittierende Polymere**
  - ➔ z.b. Plastik Displays, „Smarte Fenster", „Smartes Papier"

Source: Philips

- **Nanotechnologie**
  - ➔ neuartige Sensoren z.b. biochemische Sensoren, elektronische Nase,
- **„Wearable Computing"**

7

Technologiekonvergenz

„Ubiquitious Communication"
(any-where, any-time, any-one)

**Neue Materialien &
Sensoren/Aktoren**

„Embedded Computing"

Objekte der realen Welten werden intelligent und kommunizieren miteinander

8

4

Pilotprojekte „Inteligente Häuser"

Forschungszentren, Demoobjekte

- **inHaus-Innovationszentrum der FhG Duisburg**
  - ➔ Herstellerübergreifende Integration von Komponenten, Geräten und Services
  - ➔ „SmarterWohnenNRW": vernetzte Wohnviertel

- **HomeLab – Philips (Eindhoven)**
  - ➔ Ambient Intelligence
  - ➔ Unterhaltungselektronik
  - ➔ Z.B. Multimedia Fenster

- **Gator Tech Smart House (Florida)**
  - ➔ Einsatz von SmartX Technologien
  - ➔ Smarter Briefkasten, Fahrsimulator/Garage,
  - ➔ Positionsbestimmung, Intelligentes Bett,
  - ➔ Haussicherung, Intelligente Waschmachine,
  - ➔ Intelligenter Kleiderschrank...

Pilotprojekte „Intelligente Häuser"

Projekte in Wohnvierteln mit Bewohnern

- **Smart Home – Edinvar Housing Association (Edinburgh)**
  - ➔ Unabhängigkeit der Bewohner, Unterstützung Behinderter
  - ➔ Automatische/fernbedienbare Fenster, Türöffner, Videoüberwachung
  - ➔ Protokollierung von Aktivitäten und Gesundheitsprofilen

- **IT Neighborhood – Akalla Projekt (Stockholm)**
  - ➔ 8500 Einwohner/4300 Wohnungen über ein Informationsnetzwerk miteinander verbunden
  - ➔ Mitspracherecht, Zusammengehörigkeitsgefühl, Überwindung von sozio-ökonomischen, sprachlichen und ethnischen Hürden
  - ➔ Dienstleistungen: Kommunikation, Bildung, Kultur und Intergration, Teleshopping, Gesundheitsversorgung...

10

Betreutes Wohnen

IEEE Spektrum, Dezember 2004

Managing CARE Through the Air

Growing old in a wireless world will mean not just keeping your body healthy but keeping it online

- **2025: worldwirde population over 65 to reach 761 millions, more than double what it was in 1990**
- **Health care consumes 15% in US BIP and continues to rise**

...the next generation of older people may live in a world where every beat of their hearts and every ordinary thing they do is watched, analyzed, and analyzed for signs of trouble...

...Orwellian world, but the alternative is the loss of independence that follows when people must leave their own homes for nursing homes..

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US CAST Initiative

Center for Aging Service Technologies (CAST) in 2002
➔ **19 Firmen, 20 Universitäten, 82 Dienstleister**

Intel, General Electric, Honeywell, HP, Samsung...

America Health Tech, Meridien Health Systems, Vigil Health Solutions,...

ACTS Retirement-Life Communities, Diakon Lutheran Social Ministeries, Medical House Call Progr., Selfhelp Community Services,...

US CAST Initiative

Arbeitsgruppen

- **„Future Business and Economic Model for Aging Technologies"**
  - ➔ Wirtschaftlichkeit/Geschäftsmodelle

- **„Technology Vision Task Group"**
  - ➔ Szenarien: Wie können neue Technologien ältere Personen sinnvoll unterstützen

- **„Needs Research Group"**
  - ➔ Bedürfnisse der Pfleger und des zu Pflegenden

- **„Funding Aging Services Technologies"**
  - ➔ Förderprogramme

- **„Electronic Health and Wellness Records"**
  - ➔ Gesundheitsüberwachung und -auswertung

- **„Web Communication Task Group"**
  - ➔ Informationsplattform

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Szenario

Pillendosensensor Benutzung von Medizinbenutzung
Tassensensor Flüssigkeitsverbrauch
Bettsensor Bett in Benutzung
Badsensor Badnutzung
Schuh-/Kleidungssensor ....

Computer sendet z.B. Informationen auf den Fernseher um Demenskranke in ihrem Tagesablauf zu unterstützen

Computer erzeugen ein Abbild dessen was gerade im Haus passiert

Schlüsseltechnologie
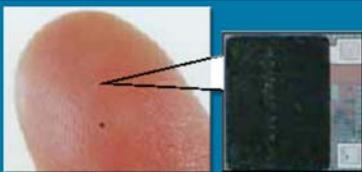**Sensornetzwerke (motes)**

Passive Sensornetzwerke

- **R(adio)F(requency)ID(entification) Tags**
  - → Passive Technologie i.e. keine eigene Energieversorgung
  - → Externes elektromagnetisches Feld liefert Energie
  - → Eingeschränkte Reichweie (<10m)
  - → Minimale Intelligenz
  - → Z.B. Warenlogistik (Metro Future Store/Rheinberg)

Hitachi node
128b ID tag
0,4 x 0,4 mm^2
30cm@30mW mit 56 x 2 mm antenna
1,15mm@300mW with integrated antenna

Photo: Hitachi

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Aktive Sensornetzwerke

Energy Scavenger

Power Conversion

MEMORY

Sensor

A/D

DSP

RF

iMote (Intel)

Photo: Jason Hill, UCB

UC Berkeley

μ-Particle = Battery, sensors, RF, CPU & memory in 1cm³

u-Particle (Particle Computer)

MicaZ (Crossbow)

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Leistungsfähigkeit

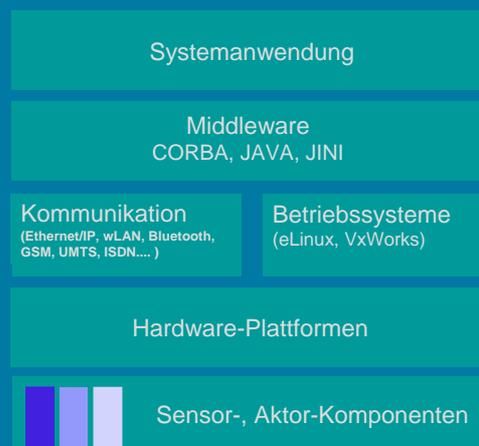|	Performanz		Stromverbrauch	
	CPU	**RF**	**CPU**	**RF**
MicaZ	7.3Mhz, 8bit AT ATM 128L	ZigBee 100m	S: 25uA A: 8mA	T: 17mA R: 20mA
iMote	33Mhz, 32bit ARM 7TDMI	Bluetooth 30m	S: <6uA A: <9mA	T: <25mA R: <25mA

Batteriekapazitäten
- Mignonzelle 1000-2000 mAH
- Knopfzelle   30-300 mAH
- Energie stark von Entladeintervallen abhängig

Energie(Kommunikation) >>Energie(Rechnen)

17

Gesamtarchitektur/Middleware

Systemanwendung

Middleware
CORBA, JAVA, JINI

Kommunikation
(Ethernet/IP, wLAN, Bluetooth, GSM, UMTS, ISDN....)

Betriebssysteme
(eLinux, VxWorks)

Hardware-Plattformen

Sensor-, Aktor-Komponenten

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A phone call away

Mobile phones have come a long way since the days when they were only used for simple phone calls. Physicians soon will be able to write and send prescriptions to pharmacies using select Sprint "smart phones" that use software from DrFirst, a Rockville, Md.-based technology solutions provider. Electronic prescription software from DrFirst is designed to help doctors write and edit prescriptions using smart phones and PDAs.

The application also offers physicians information on allergies, drug interactions, and formulary data before they complete a prescription. Additionally, it can help physicians retrieve their most recently entered prescriptions.

And paramedics in Richland, Wash., have found another innovative use for the cell phones. The paramedics send electrocardiogram data to an emergency department before a patient arrives at the hospital. The instant transmission allows hospital physicians to determine the patient's condition ahead of time and be ready when the ambulance arrives.

Using portable EKG machines, the paramedics attach 10 wires to a person's chest, take a reading, and send the information via the cell phone to Kadlec Medical Center in Richland. The image appears on a computer screen in the hospital's emergency department and can save valuable time.
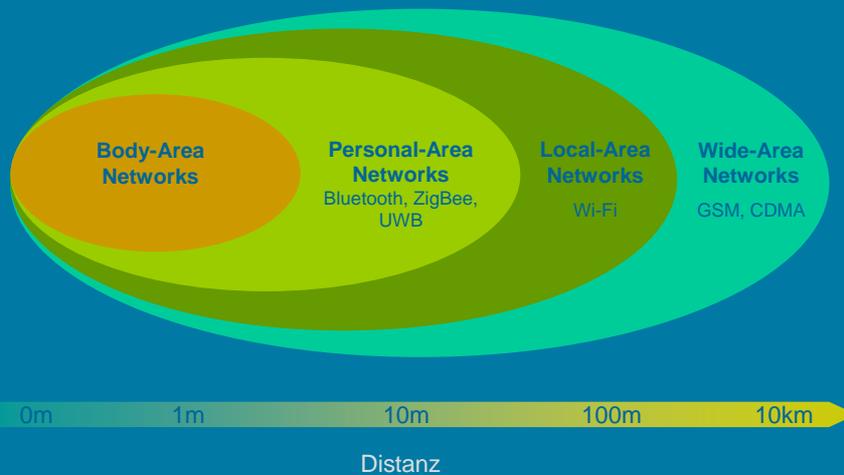
Via satellite

A new satellite-controlled pill dispenser may help patients remember to take medication. The system, which creates electronic records so pharmacists and doctors can see which pills have been taken and when, is intended for patients at home, at school, in assisted-living centers, and in prisons.

The box, which can be based on a timer or a doctor's remote control command, beeps when it's time for a patient to take a pill. Patients then push a button on the device to dispense drugs from refillable cartridges inside. Physicians and pharmacists can use the system's software and wireless communication connection to change a patient's therapy.

The system could be helpful for older patients who often don't follow doctors' orders, as well as patients with complicated drug regimens for conditions such as diabetes, congestive heart failure, and AIDS.
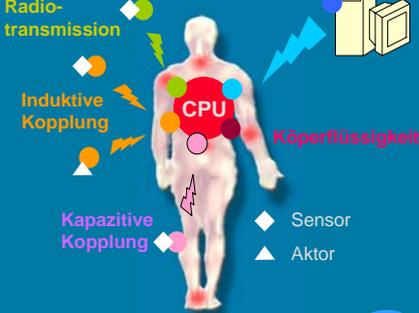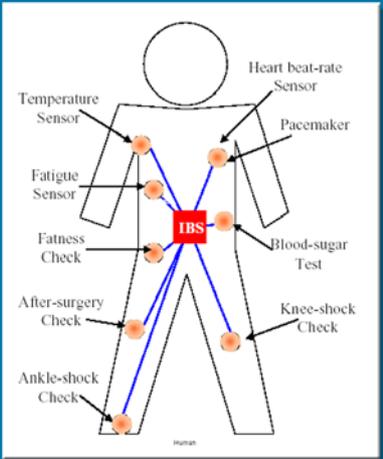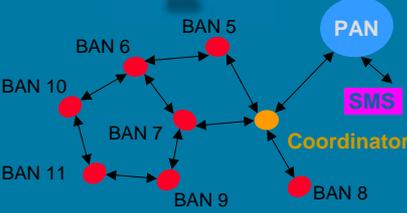

Body-Area Networks

Personal-Area Networks
Bluetooth, ZigBee, UWB

Local-Area Networks
Wi-Fi

Wide-Area Networks
GSM, CDMA

0m   1m   10m   100m   10km

Distanz

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Body Area Network

PAN/HAN

Radio-transmission

Induktive Kopplung

Köperflüssigkeit

CPU

Kapazitive Kopplung

◆ Sensor
▲ Aktor

BAN 5
BAN 6
BAN 10
BAN 7
BAN 11
BAN 9
BAN 8

PAN

SMS

Coordinator

Temperature Sensor
Heart beat-rate Sensor
Pacemaker
Fatigue Sensor
Fatness Check
IBS
Blood-sugar Test
After-surgery Check
Knee-shock Check
Ankle-shock Check
Human

Source: KAIST

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Body Area Network

„Kamerapille"
- 11 x 26 mm
- 4 Gramm
- 2 Bilder/Sekunde
- 57000 Bilder insgesamt
- Drahtlose Verbindung zu einer 9GB HDD
- Anwendung z.B. Endoskopie (8 Stunden)

Das "intelligente Pflaster" als Multisensor (2010)

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Zusammenfassung

- **Fortschritte in der Mikroelektronik, Kommunikations-technik und neue Materialien ermöglichen „intelligente Wohnumgebungen"**
- **Perspektiven für das betreute Wohnen von alten Menschen**

Herausforderungen

- **Akzeptanz**
- **Kosten**
- **Interdisziplinarität**

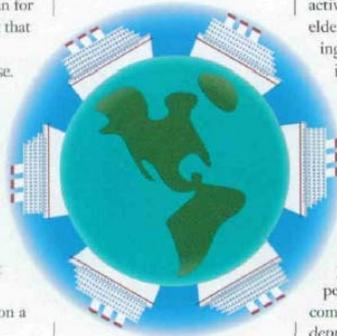- **US CAST Initiative ist ein gutes Beispiel**

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Die Alternative ☺

Cruising to Assisted Living...

Perhaps financial planners should rethink the standard assisted-living option they sometimes plan for elderly clients and suggest that instead they sign up for a year-round sea-going cruise.

The November 2004 issue of *The Journal of the American Geriatrics Society* carried an article comparing the 20-year cost of cruising year-round versus 20 years of assisted living. The costs weren't all that far apart: $230,497 for a double-occupancy cabin on a typical cruise ship versus $228,075 for the average assisted living facility. And the amenities on a cruise are equal or often superior to those in assisted living, including outstanding meals, medical facilities, housekeeping, and laundry, to say nothing of the social activities.

We're not exactly clear how the ship's crew would provide support for some of those activities of daily living the elderly can't do, such as toileting, but the concept sounds intriguing, anyway. One of the article's authors, a geriatrician at Northwestern University, Lee Lindquist, believes that cruise ships might actually be healthier places for residents because the sun, socialization, and the presence of younger people on board would combat the high percentage of depression found among those in assisted-living facilities.

The question is, will long-term care insurance pay for it?

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Dankeschön für Ihre Geduld und das Zuhören

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